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Technical Report Series

Kaministiquia River Study 1987

Technical Report #2
Thunder Bay

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NORTH SHORE
OF LAKE SUPERIOR
REMEDIAL ACTION PLANS

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NORTH SHORE OF LAKE SUPERIOR REMEDIAL ACTION PLAN TECHNICAL REPORT SERIES

Report No.

1. Beak Consultants Limited. 1987. *Survey of the Benthos of the Lower Kaministikwia River, 1985*. Prepared on behalf of the Ministry of the Environment. 114 pp.

2. Cullis, K, W. T. Momot, and R. Sein. 1987. *Kaministiquia River Study, 1987*. Ministry of Natural Resources. 148 pp.

3. Beak Consultants Limited. 1988. *Benthic Community Evaluation of Jackfish Bay, Lake Superior, 1969, 1975, 1987*. Prepared on behalf of the Ministry of the Environment. 208 pp.

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8. Wilson, L. 1990. *Historical Literature Review of the Nipigon Area with Emphasis on Fisheries from 1959 - 1990*. Ministry of Natural Resources.

9. Wilson, L. 1991. *Nipigon Walleye Historical Review*. Ministry of Natural Resources. 94 pp.

10. Sibley, P.K., D.R. Barton and D.G. Dixon. 1991. *A Twenty Year Survey of the Benthic Community at Peninsula Harbour, Lake Superior (1969 - 1989)*. Prepared on behalf of the Ministry of the Environment. 160 pp.

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Remedial Action Plan
Plan d'Assainissement

Thunder Bay

June 1, 1991

To Whom it May Concern:

Attached for your information is a copy of a report on the fish community and aquatic habitat of the Kaministiquia River in Thunder Bay. The 1987 study was undertaken as a joint effort by the Ontario Ministry of Natural Resources, Ontario Ministry of the Environment and Lakehead University.

Results from this survey suggested that habitat in the upper river supports a diverse and healthy fish community. Water quality in the lower nine kilometers of the river was found to be severely degraded as a result of low rainfall, minimal flow rates, warm temperatures, depressed dissolved oxygen levels and concentrated effluents entering this section of the river.

This report forms part of a technical report series on the water quality of northern Lake Superior, which is being prepared in support of the Remedial Action Plan program initiated by the International Joint Commission in 1986.

Yours truly,

J. Vander Wal
Coordinator
Thunder Bay Remedial Action Plan

HP: rmb
Attach.

FISH COMMUNITY AND AQUATIC HABITAT OF THE KAMINISTIQUIA RIVER

1987

K. CULLIS
LAKE SUPERIOR FISHERIES UNIT
ONTARIO MINISTRY OF NATURAL RESOURCES

W. T. MOMOT
DEPARTMENT OF BIOLOGY
LAKEHEAD UNIVERSITY

R. SEIN
LAKE SUPERIOR FISHERIES UNIT
ONTARIO MINISTRY OF NATURAL RESOURCES

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FISH COMMUNITY AND AQUATIC HABITAT
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1.0 INTRODUCTION

In 1985, the International Joint Commission (IJC) identified 42 Areas of Concern (AOC) in the Great Lakes Basin. In each of these areas benefits from the aquatic resources have diminished and remedial measures are necessary in order to restore their potential for water supplies, recreation and aquatic life. The eight Great Lakes states and the Province of Ontario are committed to develop a Remedial Action Plan (RAP) to restore all of the beneficial uses in each AOC.

Due to degraded water quality, Thunder Bay, including the lower Kaministiquia River[1], has been designated as an AOC by the IJC Water Quality Board in its 1985 report on Great Lakes Water Quality (Great Lakes Water Quality Board 1985). The first objective of this study was to obtain baseline information on the fish community of the river. This information will help to determine any possible impact on the fisheries community resulting from rehabilitation of the lower Kaministiquia River through implementation of pollution abatement measures under a RAP. The second objective was to evaluate the fisheries potential of the Kaministiquia River from Kakabeka Falls downstream. This involved identifying population characteristics for resident species of fish, transitory migrants utilizing the upper tributaries for spawning, and fish that spawn and reside as juveniles within select and unique habitats in the river.

In the spring of 1987 the Northwest Region of the Ontario Ministry of the Environment (MOE) received RAP funding to examine the fisheries potential of the Kaministiquia River and how it is affected by pollution sources on the river. The MOE commissioned the Lake Superior Fisheries Unit of the Ontario Ministry of Natural Resources (OMNR) to implement the study, appointing Dr. Walter Momot of Lakehead University, Thunder Bay, Ontario as principal investigator and scientific advisor.

The Kaministiquia River (Lat. 48°21'0", Long. 89°27'0") is the largest tributary flowing into Thunder Bay, Lake Superior (Fig. 1). The main river originates at an elevation of 427 meters (m), approximately 64 kilometers (km) northwest of the city of Thunder Bay and drains about 7,730 km^2 (IEC Beak 1983). Twin tributaries collect the controlled discharges from two Ontario Hydro storage reservoirs located at Shebandowan Lake and Dog Lake. The river flows southward from its source over Silver Falls and Kakabeka Falls, both supporting hydro-electric generating stations. It can be classified as a moderately hard-water river (32.9 - 83.0 mg/l $CaCO_3$), with alkalinity values higher than recorded for other northern Lake Superior rivers. The river gradient averages 3.4 m/km upstream of Kakabeka Falls and 0.94 m/km downstream, however there is considerable instream variation depending on location (Fig. 2). The lower 8 km section of river from the Westfort Turning Basin to the mouth has been dredged by the Canada Department of Public Works to a nominal depth of 7.6 m for shipping purposes. The river was last dredged in 1986. The Kaministiquia and McKellar Rivers will be allowed to return to their natural depth of approximately 7 m. The Mission River will continue to be dredged up to its confluence with the Kaministiquia.

[1]The Kaministiquia River has had several spellings. Kaministiquia, an Ojibway name, means the meeting of rivers or a meandering river with three mouths (Kivi 1987). In 1982, the Geographic Board of Canada selected Kaministiquia as the official spelling.

Field work on the Kaministiquia River was conducted by a four to six member crew from May 7 to September 9, 1987. The field season was split into two phases. The first involved the measurement of the physical and chemical properties of the river; the second involved an intensive fish inventory.

2.0 MATERIALS AND METHODS

2.1 Representative Reaches

The Kaministiquia River was surveyed from the base of Kakabeka Falls (km 47) to the river mouth in Thunder Bay Harbour. This section of the river was divided into eight natural zones of varying lengths termed representative reaches, defined on the basis of morphological or chemical parameters (Fig. 3 to 6; Tables 1-4). Substrate types, mean depths and widths, water quality, degree of channel sinuosity and type of water condition were the principal factors used in selecting the following representative reaches (Fig. 3 to 6):

Kakabeka (km 47 to km 44)
Harstone (km 43 to km 38)
Stanley (km 37 to km 32)
Rosslyn (km 31 to km 26)
Breukelman (km 25 to km 21)
Old Fort (km 20 to km 10)
Great Lakes (km 9 to km 3)
Mouth (km 2 to km 0)

2.2 Access

Prior to the field season, river access points were located from 1:50,000 scale topographic maps, aerial photographs and from discussion with local residents. As well, a recent video tape of the river filmed by aerial reconnaissance was viewed. Selected sites were visited firstly to determine their suitability for the portaging of gear to and from the river and secondly to obtain permission from private landowners for access. In addition several public access points were used: Kakabeka Falls Generating Station road at km 46, the Harstone bridge road at km 42, the Stanley bridge road at km 40, an unposted public access belonging to Paipoonge Township at km 38, High Street in Rosslyn village at km 31, the Highway 130 bridge at km 27, Old Fort William at km 17, and the Kam road access at km four.

Field maps sectioning the river from the mouth to Kakabeka Falls into one km reaches were prepared from Forest Resource Inventory (FRI) maps.

2.3 Habitat Transects

A habitat suitability matrix table was created employing habitat suitability index (HSI) models constructed for selected fish species (Terrel et al. 1982). The table was used to measure HSI's for each species, HSI being an indicator of species-habitat relationships. The HSI is a unitless number bounded by 0 and 1 where 0 is equated to unsuitable habitat and 1 is equated to optimum habitat. Generally, suitable habitat is indicated by a value equal to or greater than 0.4 (Terrell 1982). This provided a mathematical comparison of the reaches being evaluated, as to whether optimum habitat

may exist for a given species. Construction of the matrix table helped to initially determine which physical and chemical parameters were to be sampled. A subsample of these parameters was then selected. Each component considered two factors: the importance of each habitat parameter to one or more species, as well as the logistical feasibility of collecting and analyzing each component within the time allotted for the study.

Species selected were: walleye and smallmouth bass as representative of the coolwater component of the fish community; rainbow trout and chinook salmon as representative of the cold water components; and white sucker, common shiner and longnose dace as representative of the forage base. The latter two species which typify extreme habitat specificity demonstrate the suitability of the HSI model to detect habitat differences within various reaches of the river.

Habitat evaluation procedures employed involved: (1) defining the study area boundaries; (2) development of aquatic guilds; (3) calculation of the total area of available habitat; (4) acquiring the HSI model; (5) determining the HSI for available habitat. The river was partitioned into reaches based on physical and chemical characteristics. From a preliminary list of species known to be present, species were placed into groups utilizing a common environmental resource by constructing a guild descriptor matrix described in Terrel et al. (1982). We employed several descriptors, e.g., temperature, coldwater, rocky substrate, etc. Surface areas were calculated for each reach. Reaches were classified as to whether or not they were capable of supporting the evaluation species selected from the guild descriptor matrices.

Habitat parameters were sampled along five transects per km positioned perpendicular to the river bank at pre-selected sites. Each km was divided into five possible 200 m subsections of river. One transect was randomly selected within each subsection. For the purposes of this survey, the right bank was considered to be on the right-hand side of an observer looking downstream.

The following parameters were recorded: cross-sectional width, water depth and substrate type at 5 m intervals along the transect, shoreline features and high water mark. Instream habitat type was described in accordance with the OMNR Aquatic Habitat Inventory Survey manual (1987) (riffle, pool, run, etc.). Instream habitat classifications are documented in Appendix B. Measurements of Secchi depth, water temperature and dissolved oxygen (D.O.) were recorded and mid depth water samples were collected at each sampling station. Flow rates were measured over potential spawning substrates (Table 1).

The habitat survey commenced on May 7, 1987 at the Kakabeka Falls generating station located 46 km upstream from the mouth of the river. The portion of the river from km 46 to the Kakabeka Falls was not quantitatively studied. Diversion of river flow by Ontario Hydro to the generating station had completely dewatered this portion of the river, however a qualitative study of this portion of the river was conducted in early September.

At most transects, a steel cable marked at 5 m intervals, was stretched across the river and affixed to the opposite river bank. Water depth was measured and substrate type classified at each five meter interval. Depths were measured to the nearest centimeter employing either a meter stick or sounding chain. Substrates were categorized according to their approximate size: boulders (>25 cm); rubble (8-25 cm); gravel (0.2-8 cm); sand (<0.2 cm); silt; clay; muck; detritus and ooze (Table 2). At each station the relative percentage of each substrate type within a one square meter area (10 - 15 cm in depth) was estimated.

In navigable portions of the river, depths were obtained with a Furuno Mark IV depth sounder operated from a 16-foot aluminum boat equipped with a 25 hp outboard engine. Sounder accuracy was calibrated with a sounding chain marked at 0.5 m intervals. Sediments were sampled with a 232 cm^2 Ponar benthic sampler at three locations per transect: mid channel or greatest depth and one sample at the mid point between this location and each shore.

Water temperatures and D.O. readings were measured at maximum depth with a YSI Model 51 oxygen meter. If the weighted YSI probe failed to remain stationary in swift currents, a 500 ml bottle was used to collect D.O. and temperature samples. In areas of base gradient flow, YSI oxygen and temperature profiles were obtained at maximum depth stations. In swift currents, water transparency was measured with a weighted Secchi disk.

At the end of each km section water samples were collected for chemical analysis. Additional samples were collected at locations adjacent to probable pollution sources and at tributaries having measurable inflows. Two 500 ml MOE collection jars were filled at each station, refrigerated and delivered to the laboratory the following day.

Detailed field notes and maps of aquatic vegetation and terrain characteristics were recorded for each transect. In addition, a black and white photograph was taken and the high water mark was measured at each transect. Air temperatures in the shade and surface water temperatures were recorded with a hand-held thermometer. Transects previously sampled by the MOE were omitted. On two occasions transects were by-passed due to extremely hazardous swift currents. The habitat survey was completed on June 25, 1987.

2.4 Salmonid Spawning Habitat Assessment

During the physical habitat survey, potential salmonid spawning sites were identified and recorded in field notes. The parameters selected to identify sampling sites included: gravel size, water depth and flow rate (Raleigh et al. 1986). In early September these sites were revisited for evaluation (Table 1).

At each site, depth was measured to the nearest centimeter and the rate of flow measured in cm/sec employing a Universal flow meter Model OTTC31-00. At each site one substrate sample was taken from each potential spawning bed.

Gravel was extracted to approximately a 25 cm depth and then rinsed through a series of four vertically stacked sieves (19 mm, 12 mm, 1.5 mm and $\leq$ 1.5 mm mesh size). The percentage by volume of each of the four size categories of gravel present within the sample was then calculated.

This study employed two measures of sediment in gravel beds. Field sieves measured substrate size by volume in potential spawning areas. Particles $\leq$1.5 mm were termed silt while particles < 12 mm but > 1.5 mm were termed coarse sand (Appendix G). However the HSI model for chinook salmon listed alternate particle size measurements to determine percent fines in the gravel. Therefore the variable V_{10} in the HSI model was modified to accommodate this study's definition of average percentage of fines in the spawning gravel. Two curves were presented in the model for this variable. Curve A is for fines $\leq$ 0.8 mm in size (silt) and Curve B is for fines > 0.8 to 3.0 mm in size (sand). Since our measurements were for particles $\leq$ 1.5 mm as silt we decided to create a curve comprised of the mean between Curve A and Curve B. Comparisons of our data for silt (particles $\leq$ 1.5 mm) were then made with the new curve to generate individual SI (Suitability Index) values for variable V_{10} (percent fines) (Appendix G). This is a conservative

measure for V_{10} since it was taken prior to fish spawning (i.e., before fish have cleaned the surficial gravels) and it includes particles greater than 0.8 mm in size. Since chinook salmon spawning activity has not been observed in the river, variable V_{10} could not be measured within 30 days as specified by the model.

Finally the limiting factor model for measuring overall HSI values for chinook salmon was applied. This option is the most conservative since it assumes each variable significantly affects the ability of the habitat to produce salmon. High SI values in some variables cannot compensate for low SI values in other variables. Reaches with an SI variable less than 0.5 were considered unsuitable.

2.5 Fish Inventory

Six types of fish collection gear were employed depending upon the physical characteristics of the sampling location. Collection gear included a Smith Root GP 5.0 stream-side electroshocker equipped with two anodes, a 9.1 m bag seine, two gangs of index gillnets 106.7 meters in length, one large mesh gillnet (20 cm stretched mesh) 69 meters in length, two 1.8 meter trapnets, two 1.4 meter fyke nets, as well as angling gear. A Smith-Root electroshocking boat (SR-20) owned by he Ontario Ministry of Natural Resources and operated by Ecocern Ltd. was available for four nights. Index gillnet and shocker boat stations were chosen randomly. All other sampling stations were chosen either from sites identified and mapped during the physical habitat survey or by selecting the most suitable sites encountered along a stretch of river. The number of sites per reach depended on the variety of fish habitat present. Each habitat type within a reach was sampled at least once.

The stream-side shocker was utilized from late June until the end of July. This gear was most effective in riffle areas, in locations with thick bottom litter and in thickly vegetated areas. A predetermined 100 meter stretch of river was selected at each sampling site for electrofishing. Shocking sites selected for sampling were not disturbed prior to electrofishing. The crew moved upstream with anodes held from one to three meters apart and one netter collected fish on the outside of each anode. Captured fish were placed into a container located in an inflatable rubber raft which also served to store undeployed cable. Stations were sampled within one-half to three quarters of an hour and then captured fish were processed on shore.

The bag seine fished effectively over soft substrates and in deep pools. Hauls covered an average distance of 20 meters. In deep water, unsuitable for wading, seines were deployed from a boat and hauled in on shore.

Trapnet use was restricted by currents and water depth. Suitable trapnet sites were located between the oxbow at Old Fort William (km 20) and the mouth of Mosquito Creek (km 10) (Fig. 5). This area was navigable by motor boat, therefore nets were set at dusk and lifted at dawn to avoid net damage and potential conflicts with boaters. Even in minimal currents, nets occasionally collapsed and samples were discarded. Catch-per-unit-effort (CPUE) was calculated for each species caught.

Fyke nets, fished in areas of minimal flow, proved effective in sampling nearshore backwater areas and in areas in proximity to islands. Fyke nets were set at an angle into the current; otherwise the net rolled, closing the funnel. Fyke nets were especially effective in those areas of sufficient current that occasionally caused trapnets to collapse.

Sport species were angled in locations not suitable for other sampling gear. Effort was not quantified, however fish attribute data were collected from the catch and numerous fish were tagged and released.

Standardized gillnets, consisting of seven 15.2 meter panels of different mesh sizes (38, 51, 64, 76, 89, 102, and 114 mm stretched mesh) were set from km 19 to the river mouth. Each km was stratified into 100 meter sections. Within each km a single location was randomly selected for sampling. CPUE measured as species caught per set was calculated. Comparisons were then made between morphologically similar river reaches located above and below the Canadian Pacific Forest Products Ltd. mill. Oxygen-temperature profiles were recorded at net locations.

As with index gillnet stations, electrofishing stations were randomly selected from km 14 to the river mouth. Stations were sampled with the electrofishing boat on the nights of July 29 and 30 and August 18 and 19. Sampling was conducted at night with a five person crew. Each run lasted approximately 1,000 seconds and paralleled the shoreline as close to the river bank as water depth permitted. Three to four stations were sampled per night dependent on the catch size and processing time. For a detailed description of methods and sampling rationale refer to Dalziel (1988).

Fish collections began at the Kakabeka Falls Generating Station on June 29, 1987 and proceeded downstream. All catches were counted in the field and unidentifiable species were preserved in 10% formalin for identification in the laboratory. Total lengths were recorded for all fish collected. Small fish were subsampled if numerous.

Fork lengths, total lengths, weights and ageing tissues were collected from all sport and selected non-sport species. A total of five fish were sampled within each 2 cm size increment for yellow perch *Perca flavescens* and rock bass *Ambloplites rupestris* and within each 5 cm size increment for common white sucker *Catostomus commersonii*, longnose sucker *C. catostomus*, redhorse sucker *Moxostoma* sp., walleye *Stizostedion vitreum*, smallmouth bass *Micropterus dolomieui* and northern pike *Esox lucius*.

Originally, each of the principal sport species was to be completely sampled (sex, gonadal development, stomachs and extra ageing tissues) until each length increment category was filled. All additional captured fish were to be tagged and released. Sample size was not large enough to fill length increment categories, therefore a random sample was selected for complete sampling. All sport fish were tagged with either sutured spaghetti tags or anchor tags inserted with a Dennison Mark II tagging gun.

2.6 Data Collection and Analysis

The gradient profile of the river was obtained from the standard 1:50,000 topographic map and the 1:2,000 scale engineering map series produced by the Northwest Survey Corporation Ltd. Surface areas for each reach were calculated using an electronic planimeter.

D.O. and temperature profiles were collected by the Ontario Ministry of the Environment from April 23 to September 1, 1987 at 17 standardized stations along the lower 12 km of river. Stations were monitored weekly and at greater frequency during periods of depressed D.O. levels.

Data were analyzed with the software package RS/1 on a Micro/RSX PDP-11/73 Digital Equipment Corp. computer. Tissues for age determination were prepared and analyzed by Mr. Jon Tost of Tost and Associates (Nor Shore Environmental).

3.0 RESULTS

At the junction between the Breukelman and Old Fort reaches the river can be divided into an upper 27 km zone of five reaches, unaffected by development, and a lower 20 km zone consisting of three reaches progressively impacted by rural, urban and industrial development (Fig. 1).

While relatively shallow (mean depth 0.5 m), the upper 27 km of river averaged 128 m in width; the lower 20 km averaged 5.7 m in depth and 123 m in width (Table 1). At mid-depth over the entire river, D.O. measurements varied from less than 1.0 mg/l to 12.4 mg/l (Table 4) while surface temperatures ranged from 8.0 to 29.0 degrees Celsius (Table 5). Summer surface water temperatures were generally between 19.0 and 25.0 degrees Celsius (Table 5).

3.1 Representative Reaches

Kakabeka Reach

This 4 km reach had an area of approximately 45 hectares (ha) (Fig. 3) (Appendix B). It had the steepest gradient profile (Fig. 2) and the smallest mean cross-sectional area (37 m^2) of the eight reaches studied (Table 1). The relatively straight channel resulted in swiftly moving, shallow water, with a flow averaging 0.32 m/sec over both rubble/gravel substrates and shale gravel bars. Islands were scattered throughout the reach. The reach was primarily a riffle/run area. It also contained several pools ranging in depth from 2.0 to 3.0 m with large, partially exposed boulders (> 1 m) providing instream cover (Table 2). Two backwater areas located at km 46 and 44 (Appendix B) contained emergent and submergent aquatic macrophytes with pondweeds *Potamogeton* spp. dominating.

The river banks were primarily steep, shale cliffs with a dense mixed forest cover. River substrate consisted mainly of fragmented shale eroded from the cliffs. The percent composition of fines (≤ 1.5 mm) in gravel collected at two potential salmonid spawning sites was measured at 3 and 6% (Appendix G).

Harstone Reach

This 6 km reach included an area of approximately 69.8 ha and was the deepest (Table 1) of the five reaches surveyed in the upper Kaministiquia River (Fig. 3) (Appendix B). Pools and flat sections (comprising 90% by area) dominated this reach averaging 0.8 m in depth with sand and gravel substrates (Table 2). Numerous islands in the upper 1.5 km stretch created a highly braided channel with a maximum width of 277 m.

Beaver houses and fallen timber provided instream cover with pondweeds, sedges *Carex* spp., horsetail *Equisetum* sp., and water milfoil *Myriophyllum* sp. occurring throughout the littoral zone. The river banks varied from open flood plains to steep cliffs covered with either mixed deciduous (balsam poplar, black ash) or coniferous forest. Severe localized bank erosion occurred throughout the reach. Rural development along the right bank between km 41 and 38 created severe erosion, particularly at specific sites where livestock were permitted access to the river. The one gravel bed selected as a potential salmonid spawning bed (Station 43-5, Appendix B) contained approximately 9% total fines (≤ 1.5 mm) by volume (Appendix G).

The Whitefish River, the largest tributary located in the upper four reaches, entered on the right bank of the Kaministiquia at km 42. Turbidity increased in the Kaministiquia River at the confluence of the rivers. Measurable differences in turbidity, between the right and left sides of the channel, persisted for approximately five km downstream. Oliver Creek and Corbett Creek entered the Kaministiquia River at km 38 (Fig. 4).

Stanley Reach

This 6 km representative reach covered an area of approximately 76 ha (Fig. 4) (Appendix B). Gravel and rubble substrates occurred throughout most of the reach (Table 2). A prominent feature within an otherwise flat stretch of river was a one-half km stretch of rapids located at km 34 (Table 3). Numerous boulders (> 1 m), beaver houses and log jams provided instream cover. Thick stands of aquatic vegetation, primarily pondweeds, occurred throughout the littoral zone. River banks were generally steep and heavily vegetated with only a few localized sites of erosion. Gravel beds examined as potential salmonid spawning sites contained approximately 7 to 19% total fines ($\leq$ 1.5 mm) by volume (Appendix G).

Rosslyn Reach

This narrow, meandering 6 km reach included an area of approximately 55.6 ha (Fig. 4). The Rosslyn Reach had the greatest vertical drop per km excepting the Kakabeka Reach (Fig. 2). This reach was characterized by turbulent waters flowing over rubble and gravel substrates with large boulders (> 1 m), fallen trees and beaver houses providing instream cover (Tables 2 and 3).

River banks were either stable flood plain dominated by black ash or steep banks of mixed forest. Seeps and springs were prevalent along the right bank of the river and a single rainbow trout *Oncorhynchus mykiss* fry and adult brown trout *Salmo trutta* were captured in this area during mid summer. Three gravel beds selected as potential salmonid spawning sites contained approximately 8 to 24% total fines ($\leq$ 1.5 mm) by volume, and low percentages of course sands (1.5 to 12.0 mm in diameter) (Appendix G). Because of the many seeps and springs and low percentages by volume of particles $\leq$12.0 mm in diameter, this reach was considered to contain potential salmonid spawning and nursery habitat.

Breukelman Reach

The 5 km reach covered an area of approximately 79.5 ha and was the final reach preceding base gradient level (Fig. 2 and 4) (Appendix B). The river remained swift flowing and this reach contained the largest proportion of gravel substrate (44%) found in all of the eight reaches (Tables 2 and 3). Large islands and exposed gravel bars created highly braided sections of river at km 25 and 22 (Fig. 4). The Slate River, the largest tributary of the lower Kaministiquia, entered on the right bank of the river at km 22 (Fig. 4).

Undercut banks, brush piles and deep pools provided instream cover. Two backwater marshes containing an abundance of emergent and submergent macrophytes occurred at km 24.5 and 23.5. Floating pondweed *Potamogeton natans*, pond-lily *Nuphar* sp. and horsetail *Equisetum* sp. were the dominant macrophytes present.

Severe localized erosion occurred along the steep, grass covered right bank, an area inundated with seeps and springs. The left bank was primarily a stable flood plain forest. A small creek, draining a large severely eroded gulch, entered on the river's right bank at km 25, depositing extensive quantities of sand downstream along the right bank of the Kaministiquia River (Fig. 4).

Nine gravel beds selected as potential salmonid spawning sites contained approximately 8 to 18% fines ($\leq$ 1.5 mm) by volume (Appendix G).

Old Fort Reach

This deep and meandering reach had an area of approximately 141.5 ha (Fig. 5). It was characterized by a slow, base gradient flow and an average depth of 2.5 m. Most of the bottom substrate was muck and sand (Table 2).

A 3 km oxbow loop intersected the main river at km 19 and reentered the river at km 20 (Fig. 5). Within this loop, an abundant and diverse flora of submergent and emergent macrophytes consisting of bur-reed *Sparganium* sp., cattails *Typha* sp., wild celery *Vallisneria* sp., pondlily *Nuphar* sp., and arrowhead *Sagittaria* sp. provided instream cover. A stagnant backwater adjoined a large farm located along the left bank within the upstream portion of the loop.

Large sections of river bank have slumped into the river denoting an area of high bank instability in the upper half of the reach. As a result of this bank erosion numerous tree clumps have fallen into the river and remain lodged up to 15 m from shore. Trees represented a major component of instream cover. Installation of riprap to stabilize the banks has been attempted along much of the lower river. Bur-reed stands, and thick stands of *Elodea* sp. occurred only in isolated areas of the littoral zone.

Great Lakes Reach

This 7 km reach averaged 180 m in width, 7.2 m in depth and covered approximately 126.6 ha (Fig. 6) (Appendix B). The portion of this reach between km 8.5 to the river mouth has been dredged to a depth of 7.6 m. The Great Lakes Reach contains the largest volume of water and greatest cross-sectional area within the entire river (Table 1). The substrate was composed primarily of organic ooze and muck with high concentrations of tubificid worms present (Table 2).

The left river bank was dominated by concrete or steel docks fronting flat industrial land. The right bank alternated between flat, sand covered shorelines and steep vertical cliffs. Fallen timber slumping off the right bank formed most of the instream cover. Dominant aquatic flora consisted of isolated stands of pondweed extending to a distance of 10 m from shore.

Mouth Reach

This 2 km reach had a surface area of approximately 36.4 ha (Fig. 6). Because of an upstream incursion of cold and well oxygenated Lake Superior water, this reach was treated separately from the Great Lakes Reach. The water quality is typically less degraded in this river section compared to the preceding reach.

3.2 Fish Inventory - Total

A total of 11,633 fish representing 40 of the 44 species known to occur were collected within the entire study area. Six gear types were employed over a total of 195 collecting stations (Table 6). Angling yielded an additional 70 fish (Table 7).

Suckers (Family Catostomidae) were the most abundant fish collected. They comprised approximately 24% of the total catch of all species (Table 8). Of the four catostomid species captured, approximately 88% were white suckers, collected at 74% of all stations (Table 8).

Sport fish collected include walleye, smallmouth bass, northern pike, yellow perch, black crappie *Pomoxis nigromaculatus* and rock bass. Collectively they represented 26% of the total fish fauna collected (Fig. 7). Smallmouth bass, the most abundant sport species captured, comprised 5.5% of the total catch and 21% of total sport fish collected. This species was encountered at 50% of all stations sampled (Table 8). Young-of-the-year (YOY) fish, which were ubiquitous throughout the littoral zone, comprised most of the smallmouth bass catch.

Collecting gear was selective for individual species and size-classes. The bag seine and the stream-side electroshocker selected for small fish of all species. The remaining gear selected for larger size-classes of both sport and non-sport fish.

The bag seine captured the largest average number of fish per station (89) as well as the greatest number of species (29). Fyke nets were the least efficient gear. Fyke nets collected an average of 3.1 fish/station and only captured 6 individual species (Table 9).

3.3 Fish Inventory by Reach

Kakabeka Reach

Eighteen species were collected with the seine and stream-side electroshocker from 11 stations within the Kakabeka Reach (Table 10). White sucker was the most abundant fish collected, comprising 56% of the total catch. Sculpins *Cottus* sp. and longnose dace *Rhinichthys cataractae* were encountered at 80% and 70% of all stations respectively and were the most prevalent species throughout the reach. The collection of fourteen young-of-the-year walleye seined at km 44 may indicate that this reach may be an important walleye nursery area (Table 10).

Harstone Reach

Nineteen species were collected from 36 stations in the Harstone Reach. Six new additional species were collected with five gear types employed (Table 11). White sucker was the most abundant and prevalent species collected. This species comprised 37% of the total catch and was found at 78% of the stations. Young-of-the-year smallmouth bass and walleye were collected from 53% and 28% of the stations respectively (Table 11). Large schools of white sucker fry were observed throughout the entire reach, especially downstream of station 42 (Fig. 3).

Stanley Reach

Four gear types fished in the Stanley Reach yielded 28 species from 20 collection stations. Rainbow trout parr, the seventh additional species collected, was captured adjacent to the mouth of Oliver Creek (Fig. 1). White sucker, the most abundant and prevalent species, comprised 34% of the total catch and was collected at 90% of the stations (Table 12). Smallmouth bass was the most prevalent sport species, observed at 65% of all stations. White sucker fry were abundant along near-shore areas, particularly at km 34.

Rosslyn Reach

Twenty species were collected from 18 collection stations employing five gear types. A single adult brown trout was the only new species collected (Table 13). Smallmouth bass was the most abundant species collected, comprising 19% of the total catch; white sucker was the most prevalent species, collected at 72% of all stations (Table 13). Large schools of white sucker fry were

observed along shoreline habitats and in some cases decreasing water levels isolated fry in small pools. A single rainbow trout fry was collected in the Rosslyn Reach. Angling success was highest throughout the Rosslyn Reach and accounted for approximately half of all angled smallmouth bass.

Breukelman Reach

Five gear types captured twenty-one species from 20 sampling stations in Breukelman Reach. No additional species were collected in this reach (Table 14). White sucker, the most abundant species collected, comprised 34% of the total catch; smallmouth bass was the most prevalent species found at 95% of all stations (Table 14). Fish fry were abundant along shoreline habitats and in backwater areas located throughout km 25 (Fig. 4). Angling success for both smallmouth bass and walleye was high throughout this reach.

Old Fort Reach

Twenty three species were collected from 67 collection stations, employing five gear types (Table 15). Three additional species were collected: lake sturgeon *Acipenser fulvescens*, black crappie and alewife *Alosa pseudoharengus*. Rock bass was the most abundant and prevalent species collected. This species comprised 33% of the total catch and was encountered at 79% of all stations. Sport species were prevalent throughout the Old Fort Reach. Ninety-one percent of black crappie collected in the entire river were caught in the loop at Old Fort William. Black crappie was encountered at three collecting stations and only one specimen was a young-of-the-year. Silver redhorse, *Moxostoma anisurum*, was abundant throughout the Old Fort Reach. Sixty-six percent of all silver redhorse captured in the river were caught in this reach (Table 15).

Great Lakes Reach

Three gear types were employed to capture fifteen species from 21 collecting stations throughout the Great Lakes Reach. One new species, carp *Cyprinus carpio*, was collected (Table 16). Longnose sucker and carp, the two most abundant species collected, comprised 31% and 30% of the total catch respectively. Non-sport fish comprised 85% of the total number of fish collected and 33% of all species. The most prevalent species were white sucker, longnose sucker and carp, encountered at 81%, 62% and 48% of all stations respectively. Collectively, walleye, northern pike and smallmouth bass comprised only 1.7% of the total fish collected in the Great Lakes Reach (Table 16).

Mouth Reach

Four gear types were employed to capture eighteen species, collected at 11 stations (Table 17). Five new species were collected, the most noteworthy being the four-spine stickleback *Apeltes quadracus*. Spottail shiner, *Notropis hudsonius*, was the most abundant species collected, comprising 77% of the total catch; white sucker was the most prevalent, encountered at 89% of all stations (Table 17).

3.4 Habitat Suitability Indices (HSI), Age and Growth, and Food Habits by Species

Smallmouth Bass

High HSI values were calculated for smallmouth bass from the Harstone to the Old Fort reaches, with the highest value, 0.95, generated for the Stanley Reach (Fig. 8) (Edwards et al. 1983a). Smallmouth bass were collected at 95% of all stations in the Breukelman Reach and from 65% of stations in the Stanley Reach (Tables 14 and 12). Smallmouth bass was the most abundant fish caught within the Rosslyn Reach (Table 13).

The mean age and fork-length (FL) of adult smallmouth bass were 4.2 years and 26.1 cm respectively. The largest smallmouth bass caught was an 11 year old specimen (45.1 cm total length [TL], 1.5 kg) seined in the Breukelman Reach. Stomach analysis was completed on 25 smallmouth bass. Predominant stomach contents included fish remains (yellow perch), crayfish and insects. Total weight and volume of food were dominated by crayfish *Orconectes virilis* in adults and insects in YOY (Stephenson 1989).

Walleye

HSI values for walleye ranged from 0.7 to 0.8 from the Kakabeka Reach to the Old Fort Reach but declined to 0.0 in the Great Lakes Reach (Fig. 10). Walleye were common in the Harstone and Rosslyn reaches and most abundant in the Old Fort Reach (Tables 12, 13 and 15).

The mean age of captured adult walleye was 3.5 years and mean fork length was 29.9 cm. The largest specimen was captured in a trapnet in the old Fort Reach (13 years old, 58.1 cm in fork length, and weighed 2.1 kg). Walleye growth comparisons were restricted to fish aged one to five due to small sample sizes of fish greater than 5 years. Analysis of 44 stomachs indicated walleye fed primarily on white suckers and johnny darters *Etheostoma nigrum*. YOY walleye sampled were entirely piscivorous (Stephenson 1989).

Northern Pike

HSI values could not be calculated for northern pike as specific habitat data were not collected during this survey. However, northern pike were especially common in the Old Fort Reach.

The mean age and fork-length of sampled pike were 2.5 years and 36.6 cm respectively. The largest specimen was a seven year old fish, (83.6 cm, 5.5 kg) trapnetted in the loop at Old Fort William. Due to small sample sizes growth data was only obtained from fish ages one to six. Analysis of 27 northern pike stomachs indicated that white sucker predominated in the diet. Feeding habits of YOY northern pike were similar to adults (Stephenson 1989).

Rainbow Trout and Chinook Salmon

HSI values which varied between 0.45 and 0.65 indicated that the upper river contained potential habitat for these two species. Rainbow trout HSI values greater than 0.4 and chinook salmon values greater than 0.5 are considered as indicative of suitable habitat for each species. HSI values greater than 0.4 were found between the Kakabeka and Breukelman reaches for rainbow trout (Fig. 13). A chinook salmon HSI value of 0.3, indicative of low suitability for this species, was calculated for the Kakabeka Reach (Fig. 14). A possible limiting factor identified was a lack of large pools in this river reach. However the reach located immediately downstream had

sufficient large pools during low water conditions of the survey. Salmon may successfully spawn within the Kakabeka Reach. After emergence from the gravel fry may migrate downstream to areas where pool to riffle ratios are conducive to growth and survival.

White Sucker

HSI values for white sucker were variable in the upper river ranging between 0.55 and 0.8. Harstone Reach recorded the highest HSI (0.9) while the Great Lakes Reach recorded the lowest HSI (0.3) for spawning adults (Fig. 15) (Trial et al. 1983). White suckers were collected in large numbers at the Harstone Reach (29.5 fish/station), which corresponded with the highest HSI value of 0.84.

The mean age and length of white suckers were 5.5 years and 31.6 cm (FL) respectively. The oldest specimen was a 17 year old fish measuring 48.2 cm (FL).

Common Shiner and Longnose Dace

Representative HSIs for forage species were calculated for common shiners *Notropis cornutus* and longnose dace (Fig. 16 and 17). Longnose dace are commonly associated with high gradients found in swiftly flowing streams, therefore, HSI values were highest for the Kakabeka and Rosslyn reaches (Fig. 17) (Edwards et al. 1983b). Longnose dace were prevalent in the Kakabeka, Harstone, Stanley and Rosslyn reaches. Some were captured in Breukelman Reach however blacknose dace were more abundant in this reach.

Common shiners are associated with placid flowing streams and were captured at the Kakabeka, Harstone and Stanley reaches. The Harstone and Stanley sites had the highest HSI values for this species however most specimens were captured in the Harstone Reach. Common shiners were also collected at km 22 in Breukelman Reach where the Slate River joins the Kaministiquia. These specimens may have strayed from the Slate River where this species is common (Fig.16) (Hartviksen and Momot 1989).

Lake Sturgeon

Lake sturgeon were collected between km 18 and km 9 (Fig. 5). The mean age and length of the 24 specimens sampled were 5.1 years and 45.9 cm (TL). The catch was dominated by immature fish as sturgeon do not reach sexual maturity until age 12 to 20 for males and 14 to 33 for females (Scott and Crossman 1973).

3.5 The Lower Kaministiquia River

The lower Kaministiquia river includes the Old Fort, Great Lakes, and Mouth reaches (Fig. 1). It is the most voluminous section of river having both the largest surface and cross-sectional area. (Table 1). The Great Lakes Reach alone has a mean cross-sectional area 20 times greater than that of the upper river (Table 1).

The average, mean daily D.0. was significantly lower in the Great Lakes Reach at km 6 (3.4 mg/l) than in the Old Fort Reach at km 13 (8.7 mg/l). High daily fluctuations in D.O.s were recorded at km 6; this station recorded the lowest overall D.O. readings, with approximately half of the D.O. recordings below 3.0 mg/l (Fig. 19). D.O. levels dropped significantly within the Great Lakes Reach, rising only slightly beyond km 6 (Fig. 20). Even at the mouth, D.O. levels were significantly below (7.6 mg/l) those found upstream of the Canadian Pacific Forest Products paper

mill. D.O. levels of 2.0 mg/l were found throughout the water column at km 4 and surface D.O. levels at or near 0 mg/l were registered on several occasions. D.O. levels were lowest at a depth of approximately five meters. Seasonal D.O. levels in the lower Kaministiquia River are highly variable. Yearly lows during the 1974 to 1987 time period have been recorded in every month from May to September (Fig. 21).

Because of turbulent flow, rivers are usually chemically homogeneous (Table 4). A glance at Appendix H tends to confirm this for a variety of parameters from Station 46-1 to Station 11-5. An exception is Station 22-3 where conductivity, alkalinity, pH and true colour increase due to the inflow of the turbid, alkaline Slate River (Appendix H, Station 22-3) which drains agricultural land. The large increase in total phosphorus and total nitrogen persists downstream below station 22-3. A major change occurs at Station 10-5 with dramatic increases in conductivity, turbidity, colour, phosphorus and a corresponding decrease in transparency. As well, pH decreases by an entire pH unit as a result of discharges from the Canadian Pacific Forest Products mill. High nitrate and phosphate levels recorded below km 3 (Station 3-3) may be the result of an influx of Lake Superior water from the harbour area (Appendix H).

The CPUEs of several fish species, based on standardized shocker boat and gillnet catches, were compared between the Great Lakes and the Old Fort reaches. Shocker boat CPUEs were significantly lower in the Great Lakes Reach for smallmouth bass ($t(13)=2.36$, $p<.05$), walleye ($t(13)=2.23$ $p<.05$), yellow perch and northern pike (Fig. 22). Index gillnetting CPUEs were significantly lower in the Great Lakes Reach for walleye ($t(28)=3.68$, $p<0.05$), and yellow perch ($t'(15,13)= 3.43$, $p<.05$) (Fig. 23 and 24). There was a virtual absence of walleye, yellow perch, northern pike and lake sturgeon within the Great Lakes Reach (Fig. 23 to 26).

4.0 DISCUSSION

4.1 Relative Productivity

In this report growth, community structure, and CPUE were used as integrative measures of the effect of water quality on forage availability and habitat suitability for fish residing in the river. The growth rate of several species in the Kaministiquia River was used as an index of relative productivity in comparison with specific water bodies and provincial averages. We reasoned that growth rates, when compared to fish populations from comparable water bodies at a proximate latitude, may serve as an indicator of habitat suitability for select species given the time allotted for fish collections (two months). Since fish grow faster at lower latitudes, comparable fish growth at more northern latitudes may indicate high productivity. In addition CPUE for a number of species was calculated and community structure was described within each reach. Community structure and CPUE are used as comparative measures of productivity between the Kaministiquia River and other water bodies at the same or similar latitudes, while the HSI is employed as a comparative measure of habitat suitability within various reaches of the river.

4.2 Habitat Comparisons

The portion of the Kaministiquia River that was surveyed can be partitioned into two distinct habitat zones. The upper section (km 47-21) consists of the following reaches: Kakabeka, Harstone, Stanley, Rosslyn and Breukelman (Fig. 1). It was characterized by swift currents, moderate depths, firm substrates, high D.O. levels, high pH, low turbidity and colour, moderate conductivity, high transparency, moderate nitrogen and phosphorus levels, and surface water temperatures ranging between 19 and 25^{0}C (Tables 1 to 5). The lower section (km 20-0) (Fig. 1), consisted of the following reaches: Old Fort, Great Lakes, and Mouth. It was characterized by

slow base gradient flow, soft substrates, large pools and warm water temperatures (Fig. 2, Tables 1 and 5). Although the upper portion of this section (Old Fort) has excellent water quality characteristics, the lower portion (last 9 km) is severely degraded (Table 4; Fig. 19 and 20) and characterized by high conductivity, lower pH, high colour, high phosphorus and nitrogen levels and low transparency (Appendix H).

4.3 Upper Section

The upper section can be characterized as a cool-water fishery in the summer months with the principal resident game species being smallmouth bass, walleye and northern pike (Fig. 8 and 10). During the spring months the river has a substantial run of rainbow trout from Lake Superior. Other salmonids have also been noted within the river, namely brook trout, brown trout and in the fall, chinook salmon.

The upper section of the river also contains nursery and spawning habitat suitable for game species such as walleye, smallmouth bass and northern pike. Large gravel beds are evident in Kakabeka, and portions of the Stanley, Rosslyn and Breukelman reaches (Table 1). Kakabeka Reach serves as a nursery area for YOY walleye as does the Harstone Reach (Tables 10 and 11) (Appendix I). It has not been established if rainbow trout actually spawn in the mainstream river, however rainbow trout were collected as juveniles in the Stanley Reach and as larvae in the Rosslyn Reach. The collection of an adult brown trout in the Rosslyn Reach may indicate the suitability of this section of river for brown trout. Excellent nursery areas for northern pike are found in the Rosslyn (Appendices B-24, B-25) and Stanley reaches (Appendices B-36 to B-39) (Appendix I). Smallmouth bass juveniles were prevalent throughout the upper portion of the river and were very abundant in the Harstone Reach (Table 11).

Smallmouth Bass

HSI values for smallmouth bass indicate that the Kaministiquia River provides excellent habitat for smallmouth bass within the Harstone to Old Fort reaches (Fig. 8). The relatively rapid growth of this species and high relative abundance (Fig. 9; Tables 8, 18) is a further indication of the suitability of the river for this species.

Since provincial averages are not available, Kaministiquia River smallmouth bass growth rates were compared with data obtained from Tester (1932) and northwestern Ontario lakes (Table 18). Mean total length and weight of Kaministiquia River smallmouth bass consistently exceeded those of smallmouth bass from Tester's study sites in the Lake Nipissing region of Ontario. Comparison of Kaministiquia River smallmouth bass with those from Rainy Lake (McLeod 1984) and Little Gull Lake (Laine 1986) in northwestern Ontario show that Kaministiquia River smallmouth do not grow as fast (in fork length) as their lacustrine counterparts (Fig. 9).

Carlander (1977) reported that stream resident smallmouth bass usually did not achieve the same age as those living in lakes. Noltie (1988) reported that lake dwelling populations of rock bass also live longer than riverine populations. This may account for the low number of smallmouth bass aged > 7 years observed in the Kaministiquia sample.

Age 4 smallmouth bass comprised over 50% of the Kaministiquia smallmouth bass sample and had one of the lowest condition factors (Stephenson 1989). Competition for food and/or habitat as a result of a strong year-class may have influenced the low condition factor of age 4 smallmouth.

Walleye

Relatively high CUEs and HSI values (Fig. 10) indicate that suitable walleye habitat occurs in the entire river with the exception of the Great Lakes Reach.

The mean total length at age for Kaministiquia River walleye compared favourably with the averages from some Canadian and U.S. waters presented by Eschmeyer (1950) (Fig. 11). Rather than use conversion factors on previously published data, Kaministiquia River walleye fork lengths were compared to Ontario provincial averages (OMNR 1983). Figure 11 indicates that during the first five years of growth, Kaministiquia River walleye fork lengths were generally equal to or slightly less than the provincial averages. After five years, the Kaministiquia River sample was too small for meaningful comparisons (Stephenson 1989).

Northern Pike

Specific habitat data for the calculation of a northern pike HSI was not collected, however upstream from km 10, northern pike were prevalent throughout the river. A comparison of growth in fork length between Kaministiquia River northern pike and the Ontario averages (OMNR 1983) revealed that by age 4 northern pike fell below the provincial averages (Fig. 12). Only four pike aged at 6 years or older were captured in the Kaministiquia River.

A comparison of weight and total length-at-age between Kaministiquia River northern pike and Niagara River fish (Harrison and Hadley 1983) revealed that Kaministiquia River northern pike displayed faster growth for the first two years after which they were surpassed by Niagara River northern pike.

Differences in growth rates, often observed when examining fish from various latitudes (Scott and Crossman 1973), are attributed to the effects of climate (Krebs 1985) and the length of the growing season. The rapid growth rate of age 1 and 2 northern pike from the Kaministiquia River suggests that food availability was ample for a river at this latitude.

Within this entire fish community, northern pike appears to be largest if not the dominant predator in the Kaministiquia River. Northern pike were primarily piscivorous as adults and YOY and occasionally preyed on walleye and smallmouth bass. Northern pike were not found as a food item in the forage survey (Stephenson 1989).

Rainbow Trout and Chinook Salmon

Rainbow trout are transient migrants in the river with their principal spawning grounds occurring in tributaries of the Whitefish River. Calculated HSI values for rainbow trout were highest in the Kakabeka to Breukelman reaches (Fig. 13). River suitability as indicated by the HSI was greatest for chinook salmon in the Harstone to Breukelman reaches (Fig. 14).

Potentially suitable gravel substrates for spawning salmonids were found throughout the river, up to and especially within the Breukelman Reach. According to the HSI model, high percentages of fines potentially limit successful reproduction of chinook salmon. Fines in the redds of salmon impede water flow and impair water quality for embryos and, if excessive, could prevent their emergence.

All reaches in the upper river contain stations where fines ($\leq$ 1.5 mm) were less than 30%. Good spawning gravels for salmon were located between the Kakabeka and Breukelman reaches.

The best spawning gravels in terms of lowest combined amounts of fines and coarser sediments (sand) were found in the Rosslyn Reach at stations 30-2 and 26-5 (Appendix G).

HSI values for chinook salmon from Harstone to the Breukelman reaches varied from 0.5 to 0.6. Values are above or at 0.5, indicative of habitat suitability for this species. The Kakabeka Reach was below this value with a score of 0.3. While spawning gravels were considered suitable for this species (SI = 0.95) the model indicated that the percent pools (SI = 0.3) during the late growing season and low water period may be a limiting factor in this reach (Table 3).

Low river flows, which occurred throughout the entire summer of the study, may have exaggerated the sediment load present in surficial spawning gravels. Data collected during this survey may represent the least favourable conditions in terms of habitat suitability for salmonids in the Kaministiquia River. In more normal flow years, periodic freshets would scour these areas. All other parameters applied in the habitat suitability model were suitable for chinook salmon in all upstream reaches. These gravel beds are also a suitable spawning substrate for walleye, smallmouth bass, sturgeon and a number of forage species.

4.4 Lower Section

The lower section of the river has two very distinct zones as evidenced by examination of species composition data (Tables 15 and 16) and concurrent measures of water quality (Table 4; Fig. 19, 20 and 21). Within the Old Fort Reach several species can be added to the list of species prevalent in the upper reaches. In addition to walleye, northern pike and smallmouth bass we can add black crappie, yellow perch, rock bass and lake sturgeon to the list of species found within this section of the river (Table 16).

Smallmouth bass and walleye were abundant in the Old Fort Reach. (Table 16). Northern pike were also abundant in this reach with prime spawning habitat existing for this species in the Old Fort "loop" (Fig. 5). Black crappie, which may be restricted to the lower river, were most abundant within the Old Fort Reach (Table 15). Sturgeon were also abundant within this reach, between km 9 and km 18 (Table 16; Fig. 5). This species was collected in a variety of size and age categories and exhibited good growth for northern latitude populations. Silver redhorse sucker, present in this reach, are commonly found in slow base gradient rivers at more southerly latitudes than the Kaministiquia River. Game species were highly prevalent throughout the Old Fort Reach (Table 16).

Down stream from km 9, species composition of the fish community changed dramatically (Fig. 6; Table 17). Yellow perch, walleye, smallmouth bass, northern pike and lake sturgeon were virtually absent from this section of river (Fig. 22, 23, 24 and 25). The Habitat Suitability Index for walleye (Fig. 10), rainbow trout (Fig. 13) and chinook salmon (Fig. 14) declined to 0, confirming the unsuitability of this reach for these species.

The aforementioned species were replaced in order of abundance by longnose sucker, carp and white sucker. The HSI for adult white sucker was the highest for all species examined in other reaches but declined to a low value (0.26) in this reach (Fig. 15). This shift in community composition was so dramatic that game fish, which comprised 26% of the fauna for the portion of the river above km 9 (Table 15), declined to 1.6% of the total fish collected in the Great Lakes Reach (Table 16). A comparison of electrofishing CPUE data clearly illustrates the contrast between the Old Fort Reach and the Great Lakes Reach (Fig. 22). Within the Mouth Reach, species composition again shifted as walleye and northern pike became prevalent (Table 17). In addition, several species common to Lake Superior were captured. Water quality also improved

between the Great Lakes Reach and the Mouth Reach as a result of the lake influence. Levels of colour, turbidity and conductivity decreased while pH and D.O. increased in the Mouth Reach (Table 4). However, phosphate and nitrate levels increased in the mouth reach, perhaps as a result of the influx of Lake Superior water containing elevated nutrient levels from a harbour source (Appendix H). Not only is mean daily D.O. dramatically lower in the Great Lakes Reach compared to the Old Fort Reach, but wide daily fluctuations are evident (Fig. 19 and 20). Even at the Mouth Reach D.O. levels failed to recover to the levels occurring within the Old Fort Reach (Fig. 20).

The Kaministiquia River contains the richest fauna, from a standpoint of diversity, of any stream found on the north shore of western Lake Superior (Hartviksen and Momot 1989). Forty-four of the 82 known species in the Canadian portion of western Lake Superior watershed occur within this river. Species not collected in this survey but previously collected in the river are brook trout *Salvelinus fontinalis*, round whitefish *Prosopium cylindraceum*, threespined stickleback *Gasterosteus aculeatus*, chinook salmon and sea lamprey *Petromyzon marinus* (Hartviksen and Momot 1989). The river provides excellent habitat for smallmouth bass, walleye, northern pike, lake sturgeon, yellow perch, black crappie and rock bass. These sport fish thrive in the upper river above km 10. In addition, the river supports a substantial run of anadromous rainbow trout. With the construction of the Thunder Bay Salmon Association hatchery, the river may be subjected to spawning runs of chinook salmon and their is the potential for significant natural reproduction occurring in the river.

4.5 Rehabilitation Potential

The Great Lakes and Mouth reaches account for only 10 of 47 km of total river length, however they encompass 66% of the total volume (Table 1), and 26% of the surface area of the entire river. Hence a large proportion of the total fish habitat is not fully utilized by the fish community. This seriously reduces the fisheries recreational potential of this river, both in terms of resident sport fishes, as well as transient migratory salmonids.

The lower Kaministiquia is essentially a 20 km meandering base gradient stream consisting of three reaches: Old Fort, Great Lakes and Mouth. The latter two reaches represent a zone of degradation (Great Lakes Reach) and a zone of partial recovery (Mouth Reach) in terms of water quality. In addition to water quality degradation, prior to 1987 the channel has been dredged from the Westfort Turning Basin (km 10) to the river mouth. The Kaministiquia has three mouths: the Kaministiquia, Mission and McKellar Channels. Only the Mission (River) Channel will continue to be dredged. The other two channels will be allowed to return to natural depths of approximately 7 m. The lower river is essentially a base gradient depositional zone. The cessation of dredging in the lowermost portion of the river will produce sediment characteristics similar to those now found within the Old Fort Reach. Instream habitat conditions will consist mostly of pool habitat interspersed with some flats (Table 1). If organic effluents from the Canadian Pacific Forest Products (CPFP) mill are substantially reduced, a decrease in the organic muck-ooze substrate now characteristic of this reach may be replaced by a substantial increase in sand dominated substrates. The bottom will more closely resemble the substrate composition characteristic of the Old Fort Reach (Table 2). In addition to increased D.O. levels, abatement of water pollution from the CPFP mill and other industries should show substantial improvements in pH, turbidity, colour, nitrate and phosphate levels. Since the Rosslyn and Breukelman reaches contain substantial nursery and spawning areas for a number of species, rehabilitation of the lower river may substantially increase the carrying capacity for a large number of adult fish in the river. Pools and stream bank undercuts and vegetated areas provide protection for fishes of all ages but especially larger sized fishes resulting in high levels of standing stocks (Platts et al. 1983). The increased stream meander

(sinuosity index) for this reach is also an important factor in providing fish habitat (Table 1) and should increase with cessation of dredging.

In rivers, the edge effect provided by the normal sinuous course of a stream furnishes valuable rearing habitat for fishes and attracts them to nursery areas (e.g., Mosquito Creek, located just upstream of the impacted area, km 10) (Platts et al. 1983). An increase in meanders will increase the aquatic edge, produce pools and so increase the physical complexity and ecological diversity of this reach. Generally, the number and diversity of species in a river increases downstream. The creation of a more diverse habitat within the larger surface and cross sectional area of the two downstream reaches may provide suitable habitat for a number of fish species during various stages of development.

The decrease in turbidity as a result of pollution abatement will increase light penetration thereby increasing photosynthesis; alter water chemistry; alter physical habitat; decrease injuries to biota; alter standing stocks of benthos; and enhance reaeration (Cairns 1968; Iwamoto et al. 1978; Cordone and Kelly 1961). An improved aquatic environment will result in higher fish yields and greater survival of juvenile fish recruited into the area from upstream nursery areas. Improvement of habitat and water quality due to abatement of water pollution and cessation of dredging will permit Kaministiquia River and harbour fish populations to more effectively utilize the lower Kaministiquia River during the entire year.

Smallmouth Bass

Estimates for smallmouth bass abundance in northwestern Ontario rivers are not available. However, electrofishing within the Old Fort Reach produced a smallmouth bass CPUE comparable to that of walleye (Fig. 22). The most consistent estimates of smallmouth bass populations in Iowa streams (Paragamian 1982) suggest that a mean CPUE of 16 adults (> 20 cm T.L.) per hour of shocking was equivalent to a mean density of 109 adults/ha. Our CPUE was 9.3 bass/hour which would be equivalent to 63 bass/ha. Iowa streams are more fertile and the growing season is longer than in northern Ontario, therefore production comparisons may only be considered indicators of the upper maximum of smallmouth bass production in the Kaministiquia River.

Walleye

Estimates of walleye abundance and yield are not currently available in northwestern Ontario rivers . Within the Old Fort Reach the mean CPUE for walleye was 0.32 fish per hour in standardized gillnets. Only five walleye were caught with all sampling gear in the Great Lakes Reach and walleye were not prevalent throughout the entire lower portion of the river. CPUE increased to .71 fish per hour at the mouth of the Kaministiquia River. There is evidence that walleye utilize portions of the lower Kaministiquia during conditions of sufficient flow rates and acceptable D.O. levels (Cullis and Sein 1988; Cullis 1989). However during extreme conditions, as occurred during the summer of 1987, few walleye were captured in the lower 9 kms of the river.

Biomass and yield estimates are available for the Frederick House River, a tributary of the Moose River which is located at a more northerly latitude than the Kaministiquia (49^0 Lat.) and drains north to James Bay. In the Frederick House River the biomass of adult walleye was estimated at 0.86 kg/ha in one 14 km section, having a total surface area of 98 ha (Brousseau and Goodchild 1989). However, sauger *Stizostedion canadense* also inhabit this river with an estimated biomass of 0.91 kg/ha. Combining the two estimates placed the density of *Stizostedion* sp. for this river at 1.77 kg/ha and the estimated yearly yield at .52 kg/ha . The number per hectare

for both species was 5.35 fish. If this number was extrapolated to the rehabilitated portion of the Kaministiquia River, the number of resident adult walleye might total 867 fish. The Frederick House River is located to the northeast of the Kaministiquia with an alkalinity ($CaCO_3$) of 19.3 mg/l, compared to values ranging from 35 to 83 mg/l for the Kaministiquia. In general, the Frederick House River has a lower pH, and greater turbidity and colour than the Kaministiquia River. The Frederick House River may be less productive than the Kaministiquia River since it is located in an area of harsher climate and shorter growing season and drains nutrient-poor glacial till with large fluctuations in flow (Brousseau and Goodchild 1989). Walleye yields from lentic systems in northern Ontario are extremely variable but may represent the upper range of potential walleye yield in lotic systems of similar latitudes. In a sample of ten lakes, yield per year ranged from .13 to 3.57 and averaged 1.45 kg/ha (Trimble and Colby 1989).

The potential walleye harvest by the sport fishery may exceed local production estimates of the lower river. The influence of Thunder Bay harbour on the lower river may result in seasonal aggregations of Lake Superior walleye after rehabilitation measures have taken effect. Anglers often concentrate their effort in specific locations which may reflect production from a much larger area. For example the Michigan waters of the Detroit and St. Clair rivers have produced walleye yields in the order of 15.3 and 26.7 kg/ha respectively (S. Nepszy as cited in Trimble 1988). These fish are attracted from Lake Erie and/or Lake Huron into these rivers. Similarly fish should be attracted from Lake Superior into the Kaministiquia River. Apparently this was the case for the St. Louis River in Minnesota following water quality improvements (J. Gunderson, pers. comm.)

Northern Pike

The CPUE of northern pike in gillnets was less than that of walleye in the Old Fort Reach and was extremely variable between stations (Fig. 22, 25). In portions of the river most suitable for northern pike, slow flowing areas with abundant macrophytes, pike density as measured by index gillnetting was calculated between .5 and 2.5 fish per hour. Northern pike were not captured in gillnets set in the lower 10 kms of the river however instream habitat appeared suitable to support resident populations similar to densities observed upstream from km 10.

Mosquito Creek (km 10) and the Loop area (km 19) are examples of areas that may increase in importance as major northern pike spawning grounds following rehabilitation of the lower river. Large, sexually mature northern pike (> 5 kg) have been angled in the loop (Old Fort Reach) during April. These fish appear to be Lake Superior northern pike as large pike were not captured during the survey and are not frequently caught by river anglers during other times of the year. Northern pike were captured in the area of the river mouth (Fig. 25) in late summer gillnet sets and have been reported in the Mission and Neebing Marshes (Lakehead Region Conservation Authority 1986). Presumably, northern pike attracted to the delta area by a diverse habitat and an abundance of forage fish would enter the river under acceptable water quality conditions.

Lake Sturgeon

Lake Sturgeon inhabit the Old Fort Reach which is dominated by deep pools and soft substrates. Rehabilitation of the lower river would increase the availability of similar habitat to lake sturgeon. Lake sturgeon CPUEs in standard gillnets were 0.27/hr. This compares favourably with the Kenogami River lake sturgeon where CPUEs were reported at 0.35/hr and the population density was estimated at 12.5 large fish/km. Reports for additional northeast Ontario rivers in the Moose River Basin place sturgeon density estimates at 0.29 to 7.21 fish per ha (Brousseau and Goodchild 1989).

Growth data available for Kaministiquia River fish up to age 17 indicate a faster growing population than found in either the Kenogami River or Lake Nipigon (Fig. 18). Fast growth and the absence of mature individuals in the catch may indicate that the river upstream from km 10 provides spawning and nursery habitat to Lake Superior sturgeon populations. Remedial action on the lower river may increase lake sturgeon production in the river and ultimately enhance lake sturgeon populations in Lake Superior.

Yellow Perch, Black Crappie and Rock Bass

The three species yellow perch, black crappie and rock bass, are present in the lower river reaches and have considerable potential as a recreational resource. Their importance should not be underestimated since they could provide an urban fishery consisting of winter ice fishing opportunities and stream bank fishing opportunities in summer. The three species are important components of the angler creel within localities in Canada and the United States. In the Old Fort Reach yellow perch were twice as abundant and rock bass were eight times as abundant as the dominant sport fish smallmouth bass. Black Crappie were present in isolated areas and in low numbers. Large specimens, in the upper range of each individual species size range, were captured during the study.

Improvement in water quality and reduced turbidity would enhance macrophyte growth in the lower river. Improved instream conditions and unrestricted travel corridors to upstream spawning areas would potentially increase the river's production of yellow perch, black crappie and rock bass.

Marsh Areas

The Neebing, McKellar, Mission Island and Chippewa marshes are located at the mouth of the Kaministiquia River. These marshes comprise only 115 hectares of wetland, however are considered extremely valuable because of the importance of this habitat type to the aquatic ecosystem and the general scarcity of wetlands along Lake Superior's shoreline. Fish production in Lake Superior, a highly oligotrophic system by definition, may be limited for a number of species due to the scarcity of productive inshore habitat along much of its coastline. The current and potential production of transient and resident fish species of the Kaministiquia River are an important function of Thunder Bay Harbour marshes. Marshes contain nursery and spawning habitat, in addition to feeding and staging areas for a variety of fish species in the Thunder Bay aquatic ecosystem. Marsh studies have documented 16 fish species in the larval or YOY stage, however, actual abundance has not yet been estimated for the harbour front marshes (Cullis 1988). Previous inventories have been qualitative in nature and have not targeted on early fish life stages. Marsh habitat in Lake Michigan, however, has been shown to harbour a highly diverse and abundant larval fish community (Chubb and Liston 1986). Marshes not only provide productive nursery and spawning habitat, but also provide cover which reduces predation and maximizes survival (Johnson 1984).

Forage fish comprise a high percentage of the 33 reported species resident in the Thunder Bay marshes. The Lake Superior forage base has adequately supported the piscivorous members of the fish community, however successful lake trout *Salvelinus namaycush* rehabilitation programs and expanding Pacific salmon populations may reduce the forage base and ultimately alter community structure.

The Neebing, McKellar and Mission Marshes are located directly adjacent to rainbow trout and (potential) chinook salmon migration corridors. Highly productive aquatic habitats of this nature are utilized as staging areas for pre-spawning salmonids and represent transitional zones to smolting salmonids. When adequate nursery areas are limited within Great Lakes rivers, as may be the situation in the Kaministiquia River, it is anticipated that chinook salmon fry will migrate downstream to marshy areas at river mouths. The survival of these chinook salmon fry will probably be related to the quantity and suitability of nursery (marsh) habitat at the river mouth (OMNR 1988).

Transient Species

The Kaministiquia River is a portal for transient species migrating upstream to spawn in either the upper section of the river or its tributaries, however the current suitability and importance of this travel corridor has yet to be determined. Resident adult walleye and pike were captured in the river, however it is presumed that Lake Superior fish migrate from the bay in the spring to spawn in the river. The nearest suitable spawning grounds are located in the Breukelman Reach for walleye and the Old Fort Reach loop area for pike. Rainbow trout also use the river as an entry portal to move upstream to spawn in tributaries of the Kaministiquia (primarily the Whitefish River system) and perhaps the mainstream. Rainbow trout smolts migrate downstream in the spring and presumably, walleye and northern pike YOY move downstream in summer and fall. The river is thus used as a major travel corridor for a number of species. Furthermore, with the establishment of the chinook salmon hatchery at Kakabeka Falls, 35.3 thousand salmon smolts were stocked into the river in the spring of 1988 and an additional 187.5 thousand in 1989. The hatchery has the capacity to annually produce over 500,000 smolts.

Water quality in the lower Kaministiquia River may impede or delay fall migration of chinook salmon in some years. Water quality, which is dependent on flow rates and atmospheric conditions, is highly variable during the fall season. Chinook spawning runs generally occur between late August and mid October in the Great Lakes (OMNR 1988) and are noted to peak in the Michipicoten River, located in northeastern Lake Superior, during the last two weeks of September. The Michipicoten chinook run was, however, delayed until the first two weeks of October in the fall of 1988 (February 1989, telephone conversation with M. Pellegrini, Fisheries Management Officer, OMNR, Wawa). In the French River, located in southwestern Lake Superior, spawning migrations of spring strain chinook salmon peaked during September and fall strain chinook migration peaked during October (Close et al. 1984). In the Kaministiquia River, mean monthly D.O. measured at km 4 remained below 5 mg/l from May 5 to September 1, 1987. Fall readings are not available for 1987, however during the time period from 1974 to 1986, D.O. recovered by October to levels in excess of 5 mg/l in all cases (Fig. 20). Mean monthly values may be misleading as short term fluctuations in D.O. levels are common. In 1988, weekly D.O. levels remained above 5 mg/l at all stations and depths (1 meter intervals) except for Site N (km 3) on October 21. Levels ranged from a high of 4.9 mg/l to a low of 3.7 mg/l on October 21, 1988 (Cullis and Sein 1988). Fluctuations of this nature may trigger a short term avoidance response in migrating chinook salmon. Minimum oxygen requirements of spawning chinook salmon have been reported for the Willamette River in Oregon. Alabaster (1988) reported 3.5 mg/l as the minimum oxygen level required by chinook salmon to enter the Willamette River and Sams and Conover (1969) reported that chinook were not observed in the river until D.O. rose to 4-5 mg/l.

Degraded water quality in the lower Kaministiquia River may have a far greater impact on chinook salmon migrating downstream to Lake Superior than fall spawning runs of mature fish. There are two probable life history patterns for chinook salmon after emergence from the gravel. Immediate fry migrations occur in some west coast chinook stocks. Chinook fry move directly

downstream after emergence to nursery estuaries from mid-March to mid-May. It is anticipated that this could occur in some Great Lakes river systems, where upstream movement is restricted by barriers (e.g., dams, falls) (OMNR 88).

In the second scenario, chinook have a limited river residency prior to downstream migration. The duration is determined by environmental and physiological conditions as well as the length of the river system (OMNR 1988). Within Lake Superior, concentrations of chinook fry have been observed during late June in the Michipicoten River (February 1989, telephone conversation with M. Pellegrini, Fisheries Management Officer, OMNR, Wawa) while chinook salmon smolts left Lake Michigan streams and rivers by early June (Carl 1983).

Low water temperatures combined with D.O. levels in excess of 5 mg/l would not have restricted downward migrations of chinook salmon fry in the Kaministiquia River during April (Fig. 21) and presumably March from 1974 to 1988. Hypoxic conditions are, however, common from May to early September in the lower nine kms of river. Whitemore (1960) reported marked avoidance by 6.3 to 11 cm chinook salmon to D.O. levels between 1.5 and 4.5 mg/l in summer high temperatures. Little avoidance was observed at 4.5 mg/l under fall conditions. As temperatures increase, biological demand for oxygen by fish increases precisely when percent solubility of oxygen in fresh water decreases. In addition, fish become more active under hypoxic conditions and tend to avoid the oxygen-depleted environment (Randall 1970).

Within the water column, summer oxygen levels in the lower Kaministiquia are often lowest near surface and increase with depth. This phenomenon is caused by a wedge of Lake Superior water that extended up to km nine in the spring of 1987 (Kraemer 1988). Chinook salmon tend to migrate downstream near the stream's surface which in the case of the Kaministiquia may represent the area of lowest oxygen in the water column.

Productivity

The calculation of fish production in the Kaministiquia River was beyond the scope of this survey and cannot be attained with the limited data available. In addition quantitative fish surveys are not available for lotic systems, which may be directly comparable to the Kaministiquia River. Three, more northerly and potentially less productive river systems for which fish production information is available are the Frederick House River in northern Ontario and the La Grande and Caniapiscau rivers in northern Quebec. Yearly production of all fish species in these three river systems ranges from .5 to .6 kg/ha in the La Grande (Roy 1989) to 11.4 kg/ha in the Frederick House River (Brousseau and Goodchild 1989). Potential fish production in the Kaministiquia River may be higher due to the greater species diversity, longer growing season, relatively high nutrient levels, diverse habitat and stable flows (Tables 1-5). High nutrient levels in the Kaministiquia reflect alluvial soils typical of the watershed and agricultural activity within the basin.

The Kaministiquia River, in its present condition, may be regarded as two dissimilar aquatic ecosystems. The first system, km 47 to km 10, is a unique natural resource which harbours the most diverse fish fauna documented along the north shore of western Lake Superior (Hartviksen and Momot 1989). In addition, it is likely the most productive river located on the north shore of Lake Superior. The river harbours an abundant, diverse, cool-water resident fish fauna consisting of 44 species including six species of resident warm and cool-water sport fishes, and four species of cold-water fish.

The second system, km 9 to the river mouth, can be characterized as a zone of degraded water quality and habitat. This portion of the river receives industrial effluent from a number of sources, the largest of which is the Canadian Pacific Pulp and Paper Mill complex. Provincial Water Quality Objectives are often exceeded with respect to bacteria, trace organic contaminants, inorganic contaminants and nutrients. Oxygen depletion is a common occurrence in the lower river during conditions of low flow rates combined with high water temperatures. Extreme conditions have resulted in fish kills concentrated in the 4 km "sag area" between km 8 and km 4. The maximum effects of oxygen-demanding loading from industrial effluents can be measured in this river section. A fish kill, consisting of common white and longnose suckers, was recorded in this area on May 17, 1987 (Kraemer 1988). During this survey dead suckers were observed in the "sag area" on numerous occasions during the summer.

Evidence of habitat degradation in the lower Kaministiquia River occurs in documentation of contaminated sediments and descriptions of the benthic community. Pollution sensitive invertebrates are absent from the lower river and the benthic community is characterized by high densities of pollution tolerant tubificids. In some locations estimated tubificid densities were over 1,000,000/m^2, the highest reported in the Great Lakes Basin (OME 1987). Long-term studies conducted by the Ministry of the Environment have identified sediments contaminated with mercury in the Kaministiquia, McKellar and Mission Rivers and elevated PCB concentrations and organo-chlorine residues in sediments in the Kaministiquia River. Sediments from the lower Kaministiquia River have not been acceptable for open water disposal, therefore a long-term dredge disposal site was created in 1978 (Vander Wal et al. 1989).

An increase in water pollution coupled with a decrease in primary productivity and a corresponding decrease in species diversity results in a far less stable and diverse food web in the lower river than that found in the upper reaches. The main obstacle to realization of the river's full potential for fish production is the zone of degraded water quality and habitat within the lower 9 km of this river. If this lower portion is rehabilitated the existing Kaministiquia and Lake Superior sport fishery could be greatly enhanced and associated social-economic benefits could be significant.

In addition if potential chinook salmon spawning and nursery habitat identified in this survey is suitable for successful reproduction and survival, then the establishment of a self-sustaining stock of chinook salmon in the Kaministiquia River is possible. The chinook salmon stocking program, initiated in 1988, would result in sufficient adults returning to the Kaministiquia River to propagate natural reproduction if return rates to the stocking site are similar to published rates found in Minnesota waters of Lake Superior (.34% of chinook salmon stocked as smolts) (Close et al. 1984). Chinook salmon fisheries bring enormous economic benefits to coastal communities (Dextrase et al. 1987; Gunderson 1988). Development of a salmon fishery would create additional demands for access to the river and expanded marina facilities. A rehabilitated fish community coupled with improved accessibility to the lower river and a clean-up of the industrial shoreline zone could transform the lower Kaministiquia into an aesthetically pleasing recreational area and a source of economic benefits.

5.0 SUMMARY

The Kaministiquia River appeared to support a diverse and healthy fish community upstream from km 10 to km 46. The HSI model applied to walleye, smallmouth bass, rainbow trout, chinook salmon, white sucker, common shiner and longnose dace yielded generally favourable results for these species in the upper river. Although the HSI model does not provide conclusive results in can be used as a preliminary indicator of habitat suitability for the above-mentioned species. We can only speculate at this time whether the fish habitat in the upper Kaministiquia River is currently utilized to its maximum potential by resident and migratory fish species. Results from this survey suggest that habitat in the upper river will support increased fish production in conjunction with rehabilitation of the lower river, however this supposition can only be verified through more specific quantitative surveys.

Abundance of various sport and forage fish in the upper Kaministiquia River as measured with a variety of capture methods was indicative of a healthy riverine fish community considering the northerly latitude of the Kaministiquia River. Studies of fish yields and community dynamics in north temperate river systems is lacking making it difficult to compare the Kaministiquia River to similar loctic systems. The Kaministiquia River has a number of unique characteristics that may set potential productivity of this river at a higher level than similar lotic systems at similar latitudes. High nutrient levels throughout the river reflect the soil type characteristic of the watershed and the proximity of the Kaministiquia River to Lake Superior provide a continuum of habitat types and biota form a nutrient rich riverine system, approaching eutrophic conditions at times, to a highly oligotrophic lentic system. The river supports resident warm and cool water fish communities, may seasonally support cool water fish communities resident to the delta marshes and Thunder Bay Harbour and has the potential to support anadromous salmonids during spawning to juvenile life stages.

Growth was the third factor used to assess the state of Kaministiquia fish populations. As with abundance, few examples were available from similar lotic systems for comparison purposes. Growth of resident sport species compared favourably with provincial averages and comparable populations, indicating that food and habitat may not be limiting factors for resident fish in the Kaministiquia River.

Water quality in the lower 9 km of river was severely degraded during the summer of 1987, making for the worst possible conditions for fish; low rainfall caused minimal flow rates and warm temperatures, depressed D.O. levels and concentrated effluents in this section of the Kaministiquia River. In some years water quality may not be a major impairment to fish activity during the summer or portions thereof and water quality is generally substantially improved during all other seasons compared to the summer.

Rehabilitation of water quality and habitat in the lower 9 km of the Kaministiquia River would positively affect three components of associated fish communities: this portion of river would indisputably support a larger and more diverse resident fish community; resident river and harbour fish species may utilize the lower river during specific periods or during specific life cycle stages; and the lower river would represent an unrestricted travel corridor to upstream spawning and nursery habitat for a number of Lake Superior fish species.

6.0 RECOMMENDATIONS FOR FUTURE RESEARCH

1. Determine whether an impediment(s) exists, in terms of adult migrants and returning smolts, for rainbow trout in the lower Kaministiquia River. Determine smolt production in tributaries of the Kaministiquia River.

2. Evaluate the relative importance of Thunder Bay marshes as contributors to the sportfish stocks of Thunder Bay.

3. Determine if the lower river acts as an impediment to Lake Superior fish utilizing spawning grounds in the Kaministiquia River. Are spawning and nursery areas in the upper river reaches utilized to their full potential by river and lake fish?

4. Monitor the success of the chinook stocking program. If the river is restored a self-sustaining chinook salmon population may become established in the river.

5. Determine the extent of habitat degradation in the lower Kaministiquia River. Restoration and/or creation of fisheries habitat would be required, in conjunction with improved water quality, to maximize fish production.

6. Determine the existing sport fishing pressure in the Kaministiquia River, targeted on walleye, smallmouth bass and northern pike.

7. Assess in detail spawning habitat identified in this survey for various sport fish. This would include a measure of sediment transport and/or substrate stability.

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8.0 TABLES

TABLE 1. Physical habitat measurements for the representative reaches of the Kaministiquia River, Thunder Bay, Ontario, in 1987.

Reach	Mean transect width(m) (max)	Mean river width(m)	Mean depth (low)	Mean depth (normal)	Max. depth (m)	Mean cross sectional area(sq.m)	Mean secchi (m)	Volume (m^3)	Vertical drop (m/km)	Channel sinuosity index
Kakabeka (km 47-44)	135.3 (180)	124.0	0.32	0.65	1.30	36.9	1.16	322400	4.48	1.08
Harstone (km 43-38)	143.4 (277)	127.4	0.80	1.19	2.05	92.6	1.16	909636	1.34	1.21
Stanley (km 37-32)	133.4 (203)	133.4	0.56	0.81	2.00	71.3	0.72	648324	1.53	1.31
Rosslyn (km 31-26)	95.5 (127.5)	95.5	0.56	0.89	1.91	52.0	0.82	464130	2.20	2.30
Breukelman (km 25-21)	138.2 (316.8)	119.2	0.46	0.73	2.19	53.2	1.10	435080	1.00	1.38
Old Fort (km 20-10)	96.5 (180)	90.8	2.50	3.03	8.00	218.5	1.10	3026364	0.02	2.02
Great Lakes (km 9-3)	176.9 (412.8)	176.9	7.16	7.48	10.50	1270.0	0.65	9262484	nil	1.14
Mouth (km 2-0)	157.8 (176)	157.8	7.35	7.67	10.00	1158.6	0.87	2420652	nil	—

TABLE 2. Observed substrate composition for representative reaches of the Kaministiquia River, Thunder Bay, Ontario in 1987.

Reach	Substrate (% per m^2)										Surface area(ha)
	Boulder	Rubble	Gravel	Sand	Silt	Clay	Muck	Ooze	Detritus	Bedrock	
Kakabeka	14	43	36	3	1	0	0	0	0	3	49
Harstone	4	14	37	36	3	2	1	0	1	0	70
Stanley	17	28	28	16	3	0	0	0	0	7	76
Rosslyn	21	42	24	9	3	0	1	0	0	0	56
Breukelman	6	18	44	15	8	1	2	0	0	8	79
Old Fort	1	1	10	32	5	9	40	0	4	0	142
Great Lakes	0	0	1	0	0	3	28	67	0	0	126
Mouth	0	0	0	1	0	5	6	88	0	0	36

TABLE 3. Instream habitat conditions within each reach of the Kaministiquia River, Thunder Bay, Ontario in 1987.

Reach	Flat	Riffle	Run	Pool	Rapids
Kakabeka	47	40	13	0	0
Harstone	37	7	2	54	0
Stanley	46	11	18	18	2
Rosslyn	32	17	22	27	1
Breukelman	54	14	18	12	2
Old Fort	6	0	0	94	0
Great Lakes	0	0	0	100	0
Mouth	0	0	0	100	0

TABLE 4. Ranges in water quality parameters recorded within specific reaches of the Kaministiquia River, Thunder Bay, Ontario in 1987.

REACH	Alkalinity (mg/l) ($CaCO_3$)	Conductivity umhos/cm 25°C	pH	Turbidity (FTU)	Colour (true)	Total phosphorous (mg/l)	Phosphates (mg/l)	Total nitrogen (mg/l)	Nitrate (mg/l)	Nitrite (mg/l)	Dissolved oxygen (mg/l)
KAKABEKA	32.9	85.0	7.7	2.5	59	.011	.001	.380	.084	.003	7.4
	33.6	87.0	8.2	3.2	61	.002	.002	.440	.106	.005	10.0
HARSTONE	32.9	83.0	7.9	2.0	54	.010		.360	.082	.003	11.0
	39.1	97.0	8.3	3.2	57	.016		.440	.132	.005	12.4
STANLEY	37.0	91.0	7.7	2.5	56	.014	.001	.390	.110	.003	8.3
	53.0	129.0	8.0	17.0	86	.033	.013	.620	.140	.008	10.2
ROSSLYN	46.0	114.9	7.7	3.8	80	.020	.003	.580	.076	.004	7.0
	51.0	131.0	7.8	10.0	91	.032	.013	.620	.110	.005	10.8
BREUKELMAN	45.0	104.0	7.8	2.4	75	.015	.003	.470	.024	.004	8.7
	83.0	245.0	8.3	14.0	108	.039	.018	.740	.076	.007	11.2
OLD FORT	36.0	84.0	7.7	3.0	61	.008	.003	.430	.015	.004	6.2
	56.0	148.0	7.9	9.8	78	.024	.012	.540	.110	.005	10.6
GREAT LAKES	39.0	130.0	6.9	5.2	62	.046	.004	.590	.015	.005	0.6
	45.0	222.0	7.3	16.0	150	1.900	.075	1.200	.110	.008	10.4
MOUTH	46.0	187.0	7.2	5.1	43	.130	.041	1.100	.150	.006	8.6
											10.4

TABLE 5. Mean monthly surface temperatures (celcius) recorded in specific reaches of the Kaministiquia River, Thunder Bay, Ontario in 1987.

	REACHES						
Month	KAKABEKA	HARSTONE	STANLEY	ROSSLYN	BREUKELMAN	OLD FORT	GREAT LAKES
April							
mean	-	-	-	-	-	11.0	12.5
range	-	-	-	-	-	9-13	12-13
May							
mean	13.6	12.4	12.4	17.7	-	12.6	14.1
range	12-15	10-16	8-17	15-23	-	7-20	8-21
June							
mean	18.0	-	-	17.3	17.3	23.2	21.0
range	-	-	-	11-22	11-20	16-27	12-26
July							
mean	20.0	20.3	19.1	22.0	24.0	22.0	22.0
range	19-21	15 25	17-22	19-27	19-29	18-24	18-25
August							
mean	-	-	-	-	-	20.0	22.0
range	-	-	-	-	-	16-22	19-25

TABLE 6. Frequency of deployment of fish capture gear within each representative reach of the Kaministiquia R., Thunder Bay, Ontario in 1987.

Reach	Stream side shocker	Bag seine (9.1m)	Fyke net	Trap net (1.8m)	Index gillnet	Shocker boat	Total number of stations
Kakabeka	8	2	1	0	0	0	11
Harstone	3	26	6	0	1	0	36
Stanley	15	4	0	0	1	0	20
Rosslyn	7	7	3	0	1	0	18
Breukelman	4	14	1	0	1	0	20
Old Fort	0	29	0	12	13	7	61
Great Lakes	0	8	0	0	7	6	21
Mouth	0	2	0	0	4	2	8
Total	37	92	11	12	28	15	195

TABLE 7. Numbers and species of game fish caught by angling in the Kaministiquia R., Thunder Bay, Ontario in 1987.

Species	Numbers
Walleye	14
Smallmouth bass	49
Northern pike	7
Total	70

TABLE 8. Relative abundance and prevalence of fish species collected in the Kaministiquia R., Thunder Bay, Ontario in 1987.

Species	Numbers	Percent of total catch	Prevalence
sucker spp. *Catostomus spp.*	2745	23.6	75.9
white sucker *Catostomus commersoni*	2452	21.1	74.0
johnny darter *Etheostoma nigrum*	977	8.4	50.0
smallmouth bass *Micropterus dolomieui*	641	5.5	49.7
rock bass *Ambloplites rupestris*	1682	14.5	43.6
yellow perch *Perca flavescens*	494	4.2	41.5
sculpin spp. *Cottus spp.*	100	0.9	35.4
logperch *Percina caprodes*	403	3.5	35.4
northern pike *Esox lucius*	83	0.7	29.2
trout-perch *Percopsis omiscomaycus*	737	6.3	27.8
longnose dace *Rhinichthys cataractae*	255	2.2	27.0
walleye *Stizostedion vitreum*	114	1.0	22.1
mottled sculpin *Cottus bairdi*	154	1.3	20.8
central mudminnow *Umbra limi*	165	1.4	20.8
brook stickleback *Culaea inconstans*	55	0.5	19.4
slimy sculpin *Cottus cognatus*	82	0.7	12.5
longnose sucker *Catostomus catostomus*	287	2.5	12.3
silver redhorse *Moxostoma anisurum*	112	1.0	11.3
shorthead redhorse *Moxostoma macrolepidotum*	35	0.3	7.7
fathead minnow *Pimephales promelas*	93	0.8	6.9
carp *Cyprinus carpio*	267	2.3	6.2
blacknose shiner *Notropis heterolepis*	85	0.7	5.6
spottail shiner *Notropis hudsonius*	2008	17.3	5.6

TABLE 8. (cont'd)

Species	Numbers	Percent of total catch	Prevalence
American brook lamprey <u>Lampetra</u> <u>lamottei</u>	15	0.1	4.9
common shiner <u>Notropis</u> <u>cornutus</u>	83	0.7	4.9
lake sturgeon <u>Acipenser</u> <u>fulvescens</u>	24	0.2	4.6
blacknose dace <u>Rhinichthys</u> <u>atratulus</u>	16	0.1	4.2
creek chub <u>Semotilus</u> <u>atromaculatus</u>	44	0.4	3.5
mottled sculpin X slimy sculpin <u>C.</u> <u>bairdi</u> X <u>C.</u> <u>cognatus</u>	11	0.1	2.8
finescale dace <u>Chrosomus</u> <u>neogaeus</u>	17	0.1	2.8
black crappie <u>Pomoxis</u> <u>nigromaculatus</u>	22	0.2	2.6
burbot <u>Lota</u> <u>lota</u>	5	0.04	2.1
lake whitefish <u>Coregonus</u> <u>clupeaformis</u>	2	0.02	1.8
lake trout <u>Salvelinus</u> <u>namaycush</u>	1	0.01	1.8
fourspine stickleback <u>Apeltes</u> <u>quadracus</u>	7	0.06	1.4
ninespine stickleback <u>Pungitius</u> <u>pungitius</u>	37	0.3	1.4
alewife <u>Alosa</u> <u>pseudoharengus</u>	48	0.4	1.0
northern redbelly dace <u>Chrosomus</u> <u>eos</u>	4	0.03	0.7
smelt <u>Osmerus</u> <u>mordax</u>	2	0.02	0.7
pearl dace <u>Semotilus</u> <u>margarita</u>	1	0.01	0.7
rainbow trout <u>Oncorhynchus</u> <u>mykiss</u>	2	0.02	0.5
brown trout <u>Salmo</u> <u>trutta</u>	1	0.01	0.5

TABLE 9. Total number of species collected and average number of fish caught per collection station with the six gear types employed in the Kaministiquia R., Thunder Bay, Ontario in 1987.

Gear	Number of fish caught per station	Number of species collected by gear type
Bag seine (9.1m)	89.0	29
Index gillnets	77.5	14
Shocker boat	52.3	15
Stream side shocker	37.7	27
Trap net (1.8m)	14.5	10
Fyke net	3.1	6

TABLE 10. Relative abundance and prevalence of species collected in the Kakabeka Reach of the Kaministiquia R., Thunder Bay, Ontario in 1987.

Species	Number	Relative abundance (%)	Prevalence (% occurrence)
white sucker	219	56.2	46
slimy sculpin	39	10.0	20
longnose dace	34	8.7	70
sculpin spp.	32	8.2	80
walleye	14	3.6	9
central mudminnow	9	2.3	20
longnose sucker	7	1.8	36
mottled sculpin	7	1.8	30
sucker spp. larvae	6	1.6	55
northern pike	5	1.3	18
slimy sculpin X mottled sculpin	3	0.8	20
johnny darter	3	0.8	30
trout-perch	3	0.8	20
burbot	2	0.5	9
smallmouth bass	2	0.5	27
fathead minnow	2	0.5	10
silver redhorse	1	0.3	9
common shiner	1	0.3	10
logperch	1	0.3	10

TABLE 11. Relative abundance and prevalence of species collected in the Harstone Reach of the Kaministiquia R., Thunder Bay, Ontario in 1987.

Species	Number	Relative abundance (%)	Prevalence (% occurrence)
white sucker	1064	37.2	78
johnny darter	584	20.4	69
rock bass	442	15.5	47
logperch	208	7.3	31
smallmouth bass	141	4.9	53
trout-perch	103	3.6	48
yellow perch	88	3.1	28
longnose dace	63	2.2	41
sculpin spp.	61	2.1	59
walleye	26	0.9	28
northern pike	22	0.8	33
common shiner	22	0.8	10
blacknose dace	10	0.4	10
central mudminnow	8	0.3	14
mottled sculpin	4	0.1	10
shorthead redhorse	4	0.1	6
brook stickleback	3	0.1	6
silver redhorse	3	0.1	8
redhorse spp.	2	0.07	14
spottail shiner	2	0.07	7
blacknose shiner	1	0.03	3

TABLE 12. Relative abundance and prevalence of species collected in the Stanley Reach of the Kaministiquia R., Thunder Bay, Ontario in 1987.

Species	Number	Relative abundance (%)	Prevalence (% occurrence)
white sucker	253	34.1	90
longnose dace	121	16.3	63
smallmouth bass	80	10.8	65
mottled sculpin	76	10.2	58
rock bass	40	5.4	65
johnny darter	39	5.3	58
slimy sculpin	23	3.1	32
logperch	19	2.6	42
finescale dace	15	2.0	16
central mudminnow	10	1.3	26
brook stickleback	9	1.2	26
creek chub	9	1.2	11
American brook lamprey	6	0.8	26
shorthead redhorse	6	0.8	5
blacknose dace	6	0.8	5
yellow perch	5	0.7	10
redbelly dace	4	0.5	5
sculpin spp.	4	0.5	5
northern pike	3	0.4	15
walleye	3	0.4	15
longnose sucker	2	0.3	5
blacknose shiner	2	0.3	5

TABLE 12. (cont'd)

Species	Number	Relative abundance (%)	Prevalence (% occurrence)
rainbow trout	2	0.3	5
burbot	1	0.1	5
silver redhorse	1	0.1	5
common shiner	1	0.1	5
trout-perch	1	0.1	5
fathead minnow	1	0.1	5
pearl dace	1	0.1	5

TABLE 13. Relative abundance and prevalence of species collected in the Rosslyn Reach of the Kaministiquia R., Thunder Bay, Ontario in 1987.

Species	Number	Relative abundance (%)	Prevalence (% occurrence)
white sucker	80	10.8	72
smallmouth bass	140	18.8	61
rock bass	117	15.7	61
logperch	109	14.7	50
central mudminnow	75	10.1	50
mottled sculpin	56	7.5	50
brook stickleback	13	1.7	50
sculpin spp.	3	0.4	50
longnose dace	34	4.6	43
johnny darter	22	3.0	43
slimy sculpin	17	2.3	43
yellow perch	34	4.6	33
northern pike	6	0.8	33
walleye	5	0.7	22
trout-perch	9	1.2	21
mottled sculpin X slimy sculpin	8	1.1	21
blacknose shiner	4	0.5	21
silver redhorse	2	0.3	11
American brook lamprey	7	0.9	7
fathead minnow	1	0.1	7
longnose sucker	1	0.1	6
brown trout	1	0.1	6
rainbow trout fry	1	0.1	6

TABLE 14. Relative abundance and prevalence of species collected in the Breukelman Reach of the Kaministiquia R., Thunder Bay, Ontario in 1987.

Species	Number	Relative abundance (%)	Prevalence (% occurrence)
smallmouth bass	108	11.8	95
white sucker	314	34.3	70
johnny darter	33	3.6	61
trout-perch	74	8.1	56
yellow perch	71	7.8	55
logperch	19	2.1	50
rock bass	27	3.0	40
central mudminnow	55	6.0	33
northern pike	8	0.9	30
mottled sculpin	8	0.9	28
brook stickleback	8	0.9	17
blacknose dace	78	8.5	17
creek chub	35	3.8	17
redhorse spp.	3	0.3	15
common shiner	59	6.4	11
longnose dace	3	0.3	11
silver redhorse	2	0.2	10
walleye	2	0.2	10
slimy sculpin	3	0.3	6
American brook lamprey	1	0.1	6
shorthead redhorse	5	0.6	5

TABLE 15. Relative abundance and prevalence of species collected in the Old Fort Reach of the Kaministiquia R., Thunder Bay, Ontario in 1987.

Species	Number	Relative abundance (%)	Prevalence (% occurrence)
rock bass	1028	32.8	79
yellow perch	284	9.1	74
white sucker	228	7.3	64
johnny darter	296	9.5	61
spottail shiner	304	9.7	44
northern pike	36	1.2	40
smallmouth bass	142	4.5	40
logperch	47	1.5	35
silver redhorse	74	2.4	31
trout-perch	547	17.5	28
walleye	49	1.6	26
shorthead redhorse	19	0.6	16
lake sturgeon	22	0.7	15
central mudminnow	7	0.2	14
brook stickleback	3	0.1	8
black crappie	22	0.7	8
finescale dace	2	0.06	6
fathead minnow	6	0.2	6
mottled sculpin	1	0.03	3
American brook lamprey	1	0.03	3
alewife	12	0.4	2
burbot	1	0.03	2

TABLE 16. Relative abundance and prevalence of species collected in the Great Lakes Reach of the Kaministiquia R., Thunder Bay, Ontario in 1987.

Species	Number	Relative abundance (%)	Prevalence (% occurrence)
white sucker	124	20.4	84
longnose sucker	186	30.6	62
carp	183	30.1	48
brook stickleback	12	2.0	43
fathead minnow	18	3.0	36
rock bass	27	4.4	24
silver redhorse	29	4.8	19
yellow perch	9	1.5	19
smallmouth bass	4	0.7	14
spottail shiner	7	1.2	14
walleye	5	0.8	14
central mudminnow	1	0.2	7
lake sturgeon	1	0.2	5
northern pike	1	0.2	5
shorthead redhorse	1	0.2	5

TABLE 17. Relative abundance and prevalence of species collected from the Mouth of the Kaministiquia R., Thunder Bay, Ontario in 1987.

Species	Number	Relative abundance (%)	Prevalence (% occurrence)
white sucker	170	7.7	89
longnose sucker	91	4.1	56
spottail shiner	1695	76.6	50
ninespine stickleback	37	1.7	50
fourspine stickleback	7	0.3	50
brook stickleback	7	0.3	50
smelt	2	0.1	50
alewife	36	1.6	25
mottled sculpin	2	0.1	25
fathead minnow	65	2.9	24
carp	84	3.8	22
walleye	10	0.5	22
yellow perch	3	0.1	22
lake whitefish	2	0.1	20
lake trout	1	0.05	14
northern pike	2	0.1	11
rock bass	1	0.05	11
burbot	1	0.05	11

TABLE 18. Comparison of total length (mm) and weight (g) at age of smallmouth bass captured in the Kaministiquia River (1987) and some Ontario lakes (Tester 1932).

LOCATION		AGE 2	3	4	5	6	7
Kaministiquia River 48°21'N, 89°27'W	L	-	94	111	119	144	143
	W	-	235	359	475	800	790
Perch Lake 46° 5'N, 80°W	L	64	79	95	107	117	127
	W	57	110	220	280	380	510
Phantom Lake 46° 5'N, 80°W	L	63	68	-	106	114	118
	W	57	99	-	280	-	400
Lake Nipissing 46°15'N, 80°W	L	81	94	109	117	134	140
	W	170	230	370	480	710	790
Georgian Bay 45°11'N, 80°W	L	-	-	-	99	114	115
	W	-	-	-	370	425	425

L = Total length in mm.
W = Total weight in g.

9.0 FIGURES

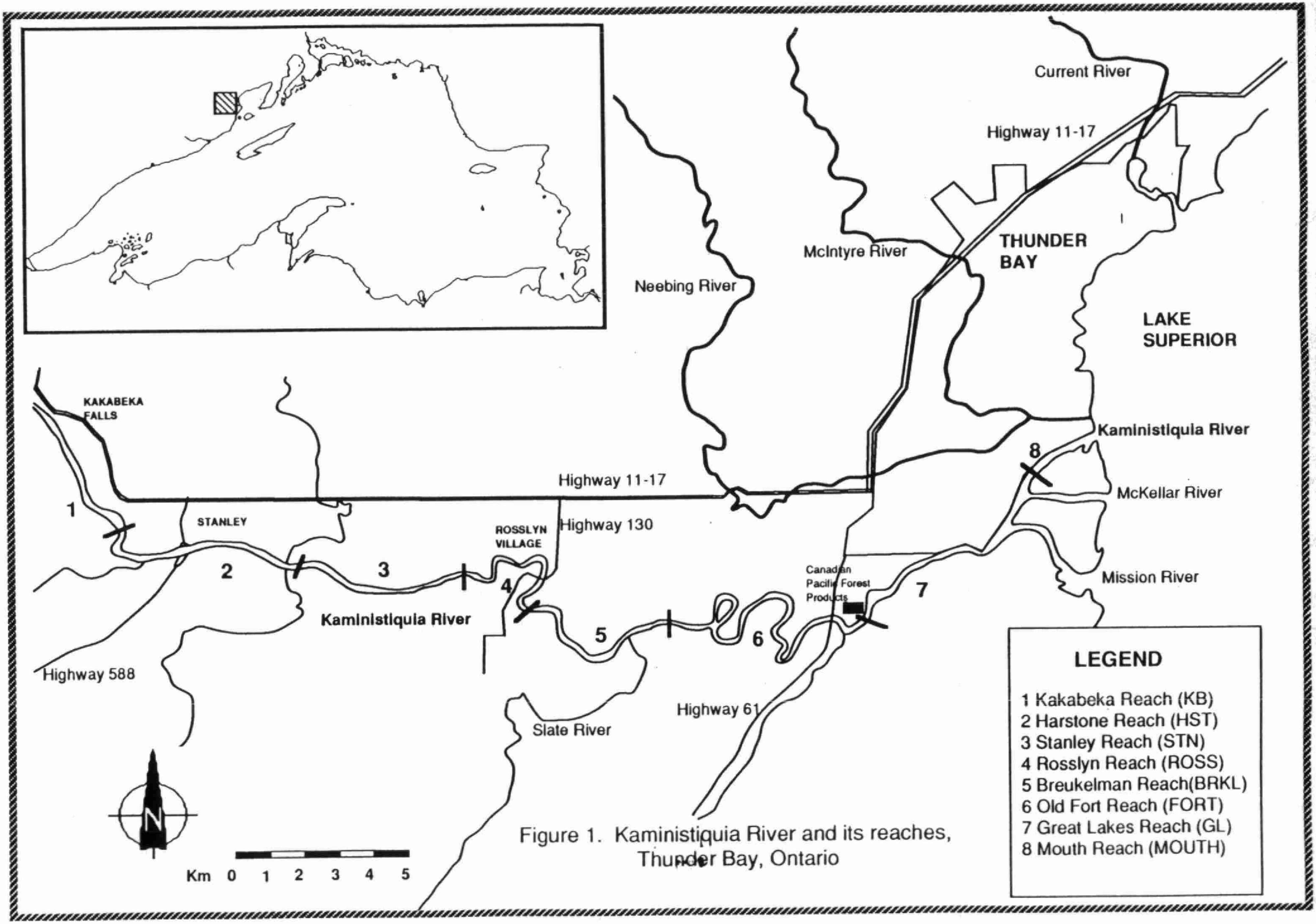


Figure 1. Kaministiquia River and its reaches, Thunder Bay, Ontario

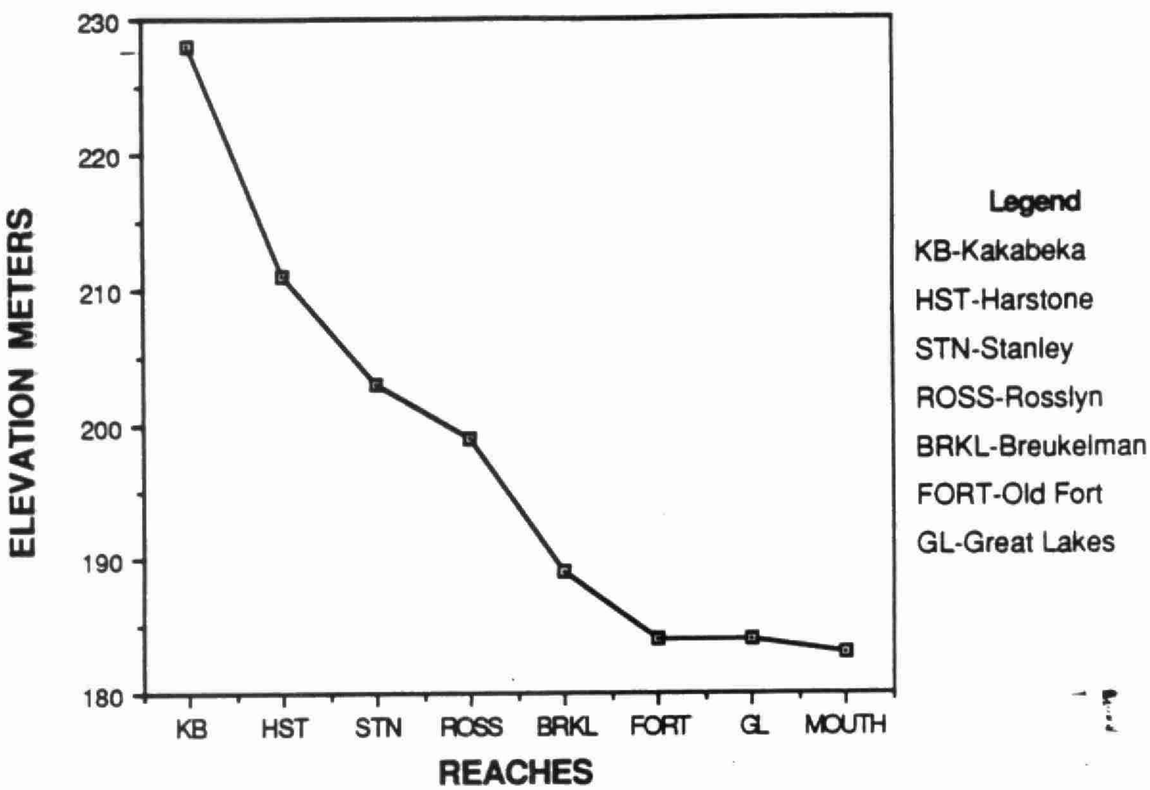


FIG. 2. Gradient profile of various reaches of the Kaministiquia River, Thunder Bay, Ontario in 1987.

KAMINISTIQUIA RIVER

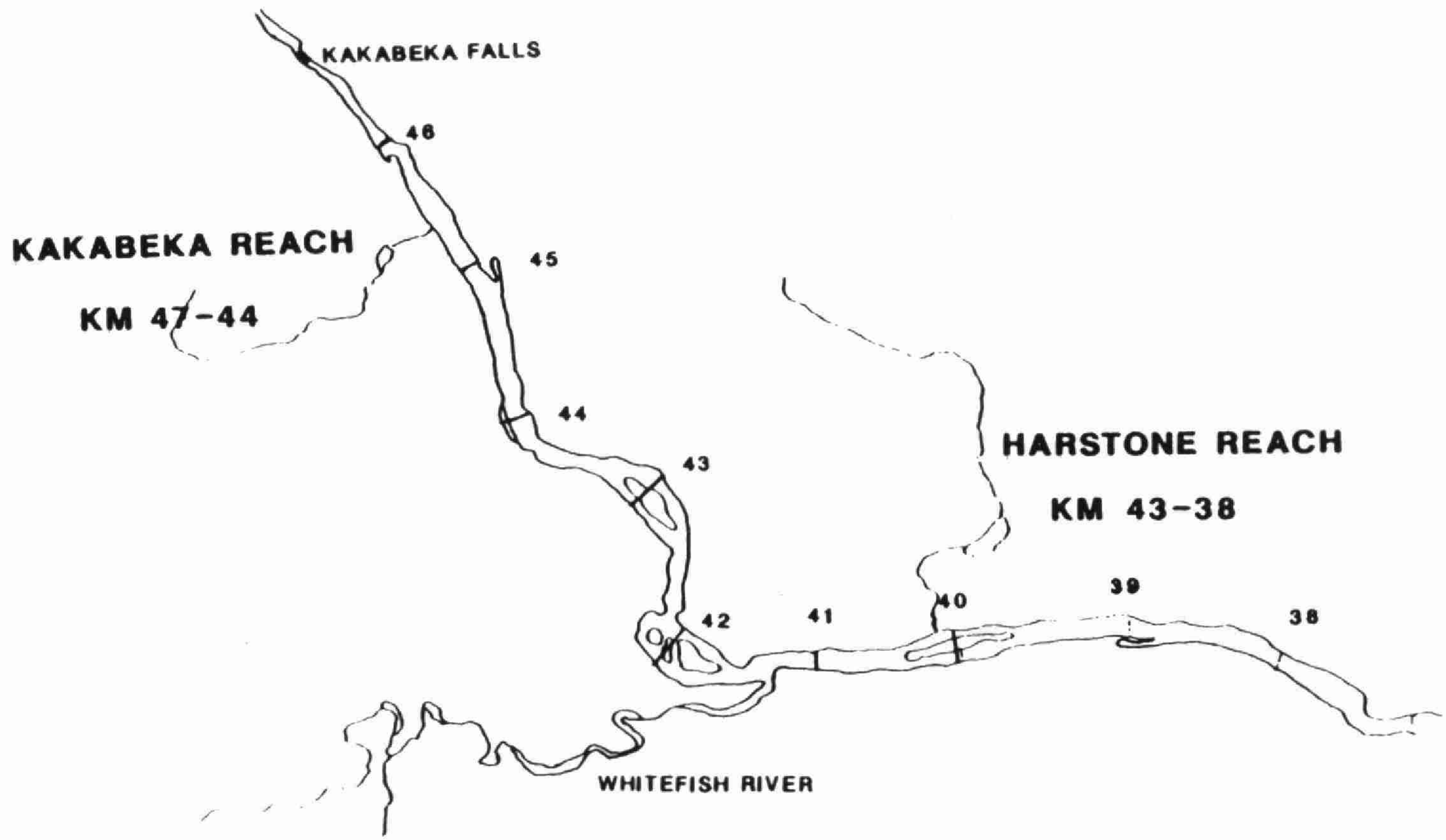


Figure 3. Composite map of the Kakabeka and Harstone reaches of the Kaministiquia River, Thunder Bay, Ontario.

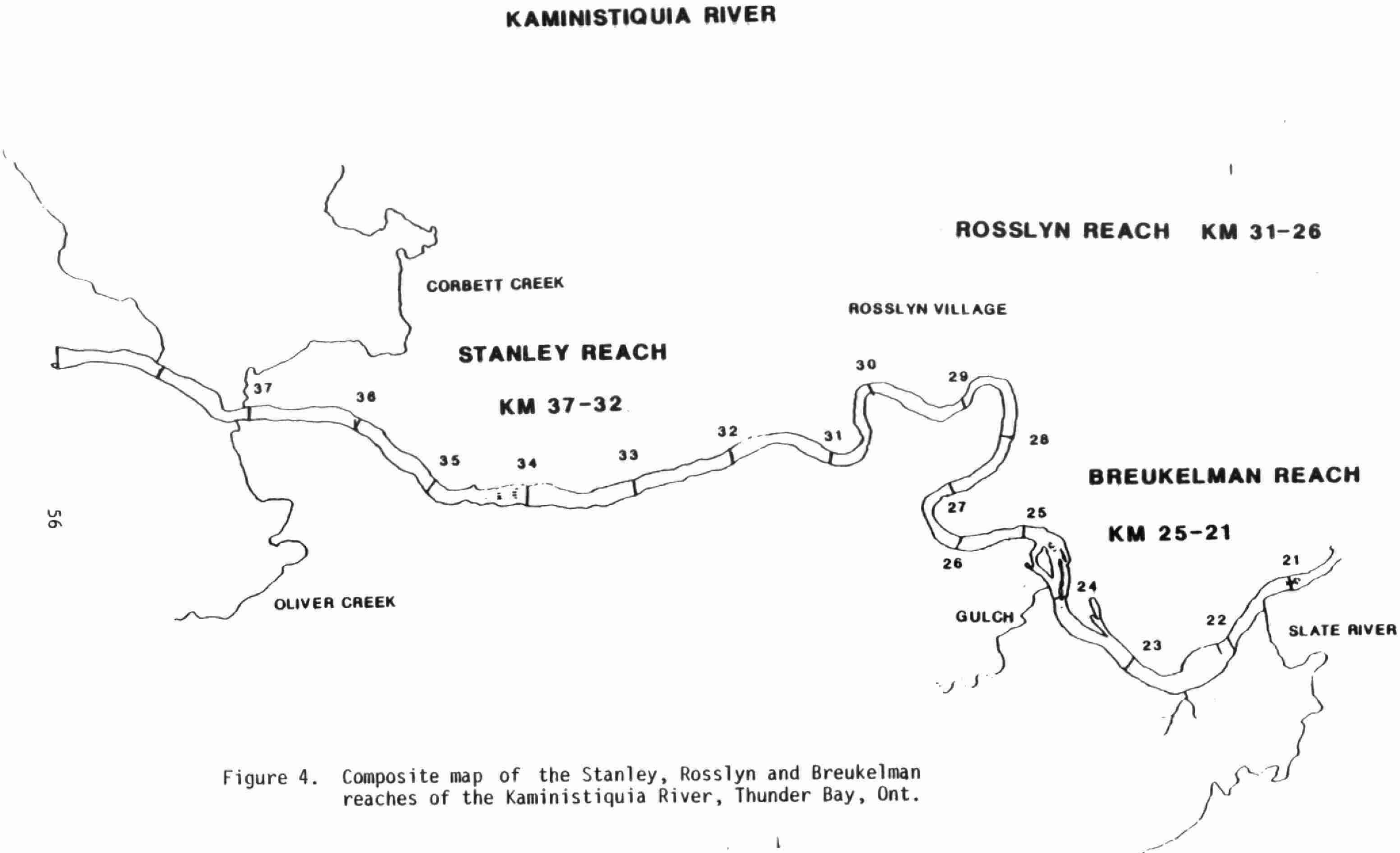


Figure 4. Composite map of the Stanley, Rosslyn and Breukelman reaches of the Kaministiquia River, Thunder Bay, Ont.

OLD FORT REACH

KAMINISTIQUIA RIVER

KM 20-10

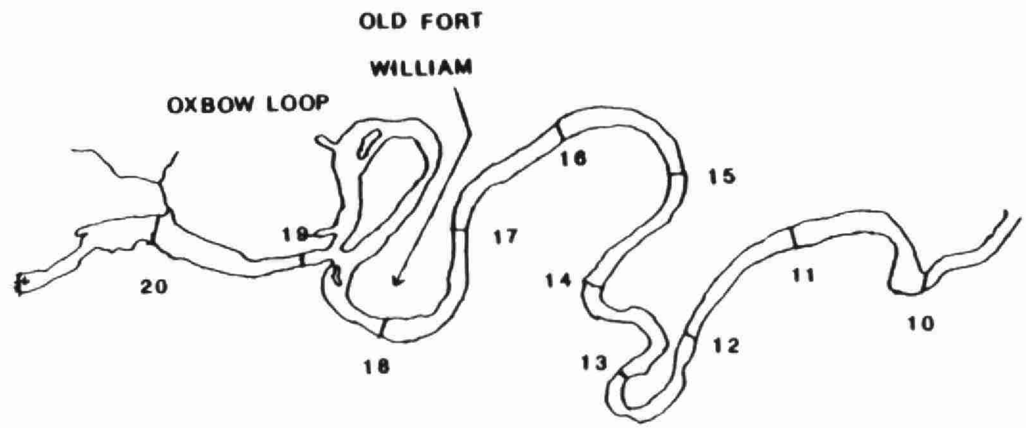


Figure 5. Composite map of the Old Fort reach of the Kaministiquia River, Thunder Bay, Ontario.

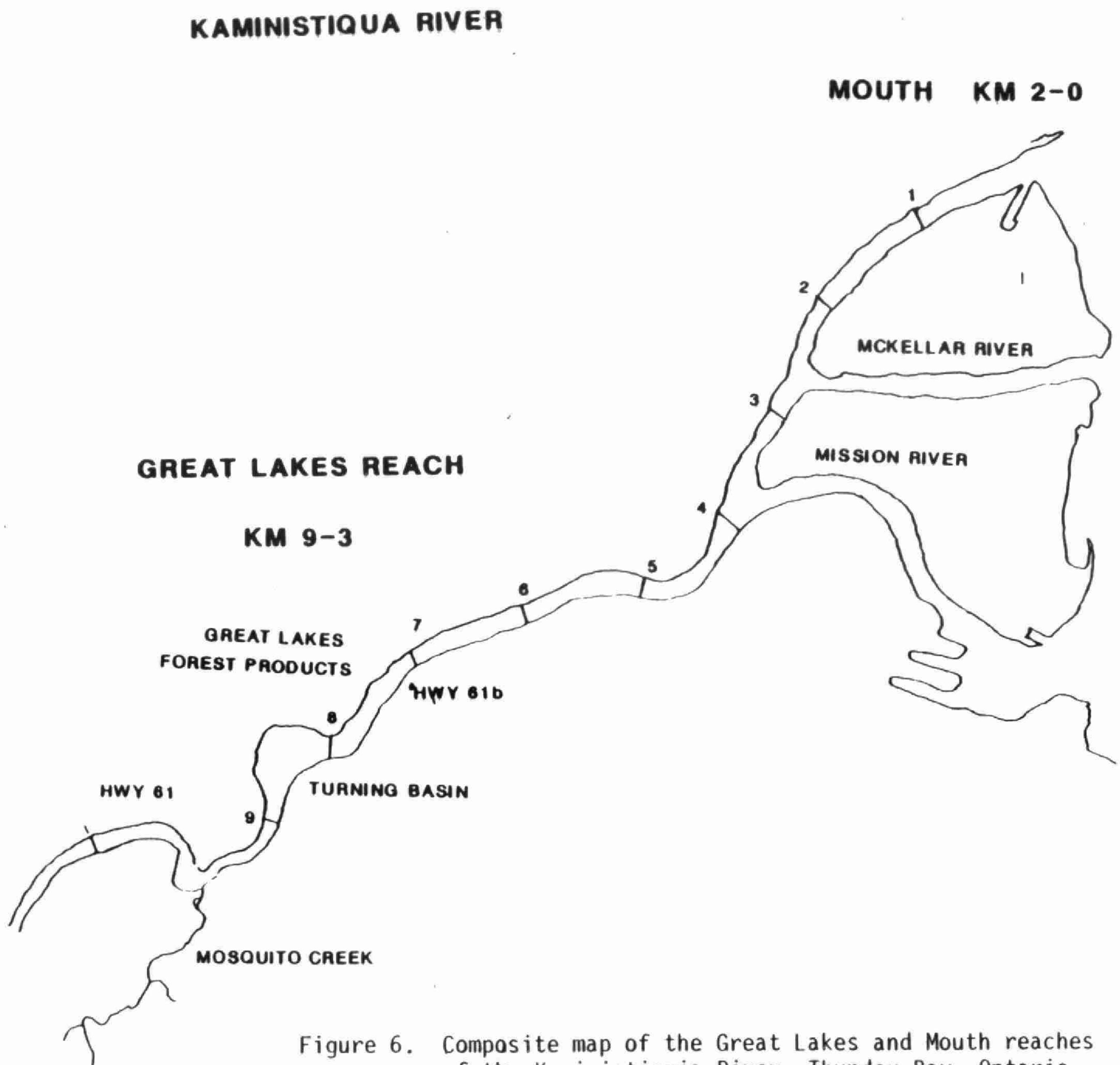


Figure 6. Composite map of the Great Lakes and Mouth reaches of the Kaministiquia River, Thunder Bay, Ontario.

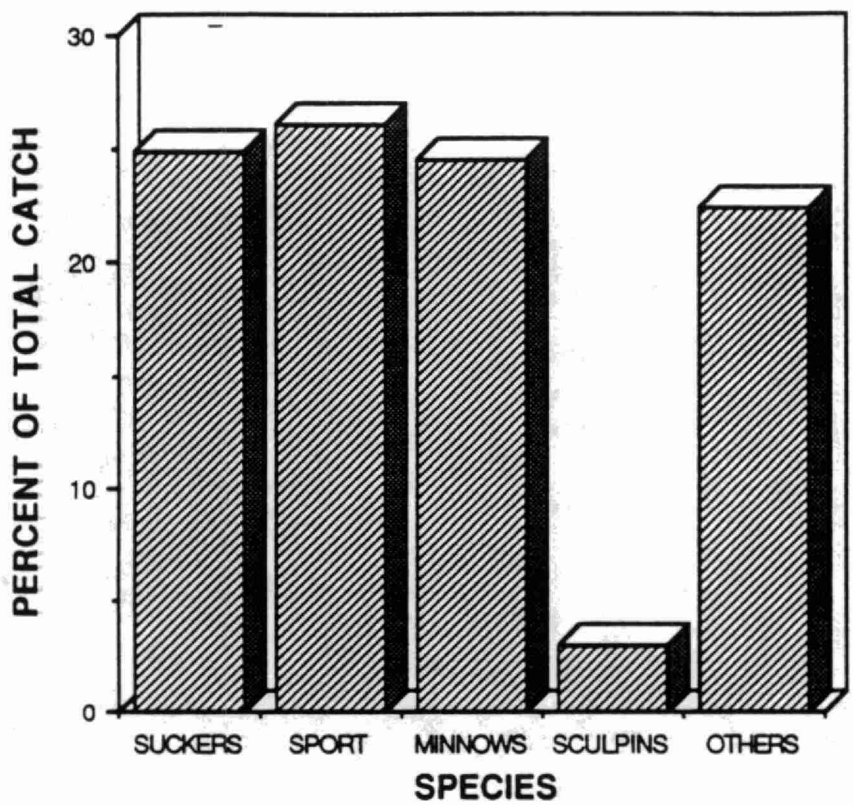
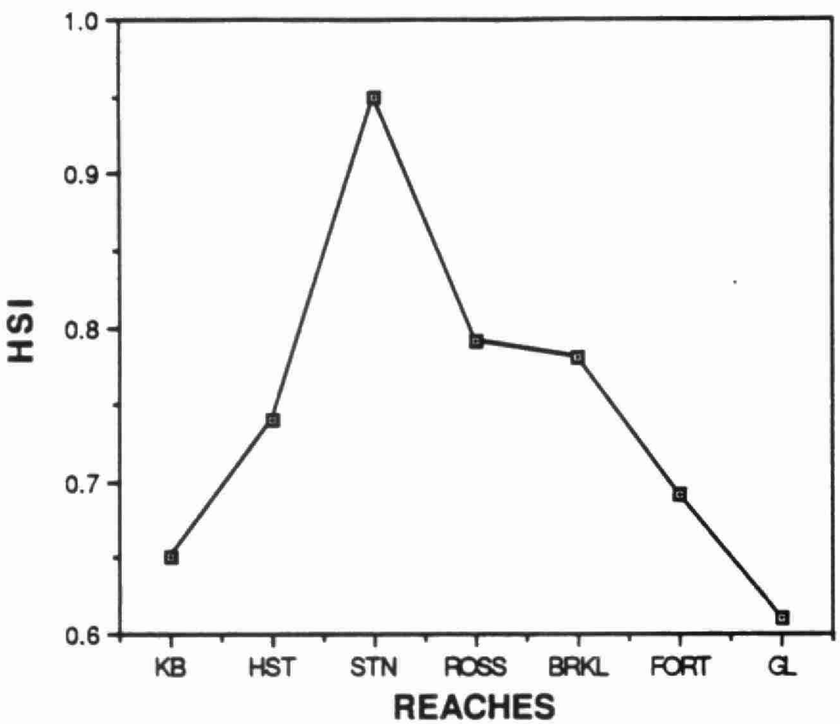


FIG. 7. Relative abundance of fish groups collected in the Kaministiquia R., Thunder Bay, Ontario in 1987.



Legend

KB-Kakabeka
HST-Harstone
STN-Stanley
ROSS-Rosslyn
BRKL-Breukelman
FORT-Old Fort
GL-Great Lakes

FIG. 8. Habitat suitability indices for the smallmouth bass for various reaches of the Kaministiquia R,. Thunder Bay, Ontario in 1987.

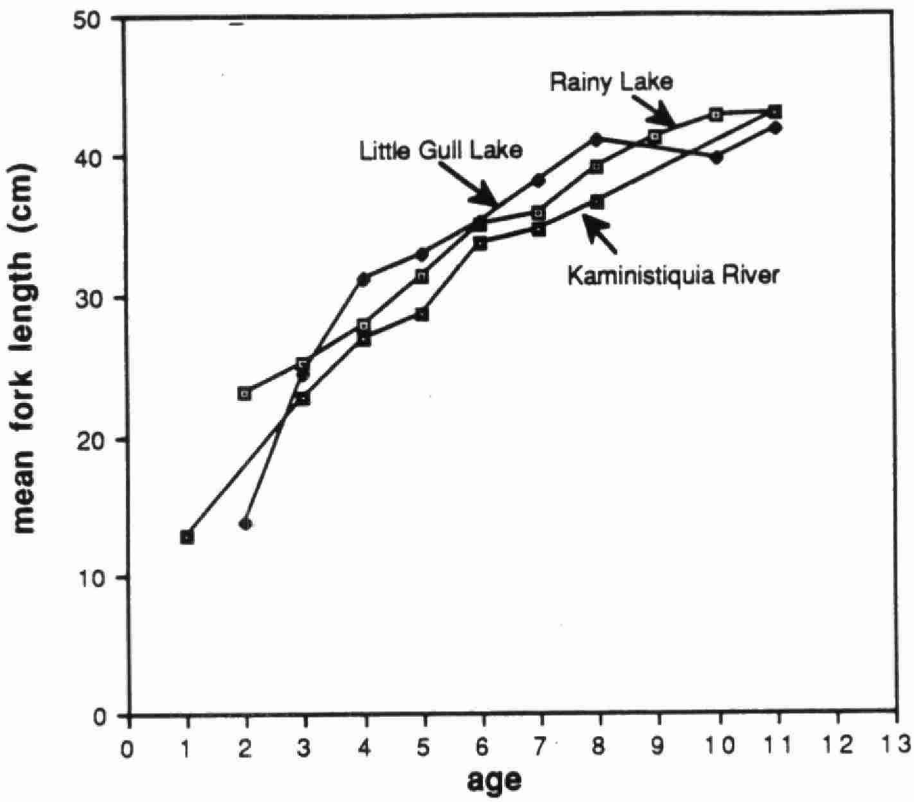


FIG. 9. Mean fork length at age for smallmouth bass from Rainy Lake (McLeod 1984), Little Gull Lake (Laine 1986) and the Kaministiquia River, Northwestern Ontario.

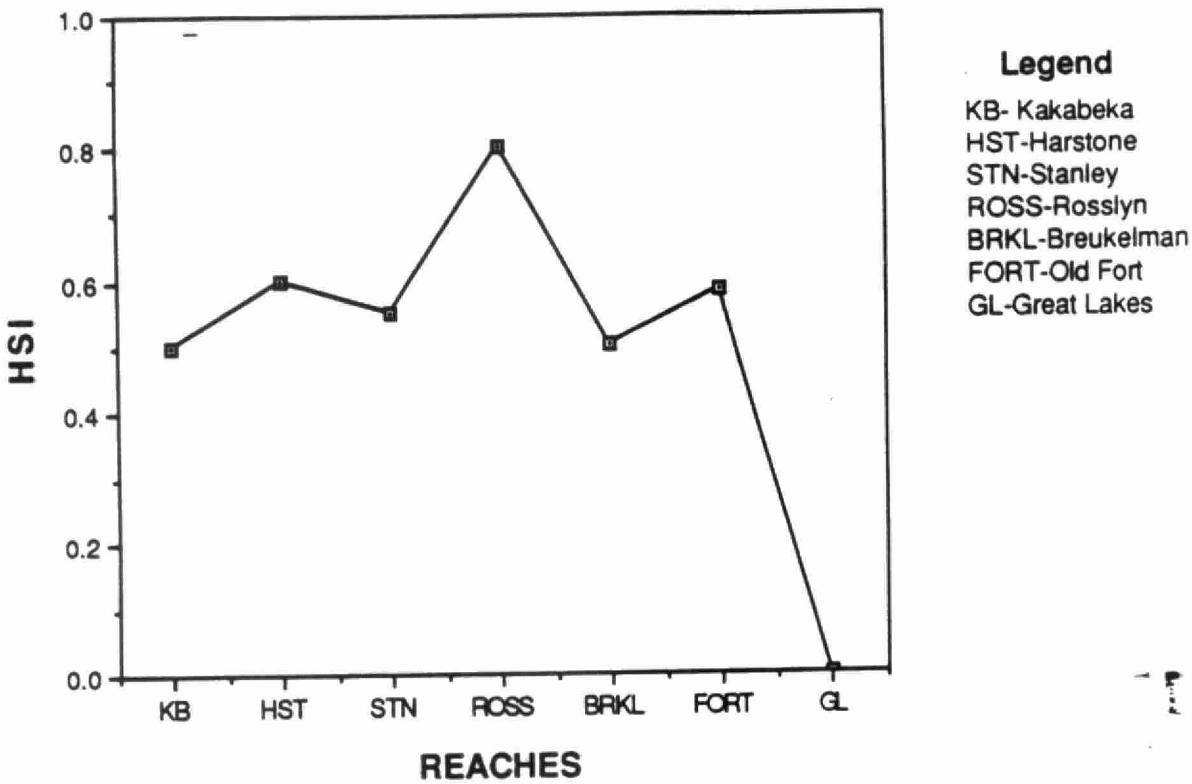


FIG. 10. Habitat suitability indices for walleye for various reaches of the Kaministiquia R., Thunder Bay, Ontario in 1987.

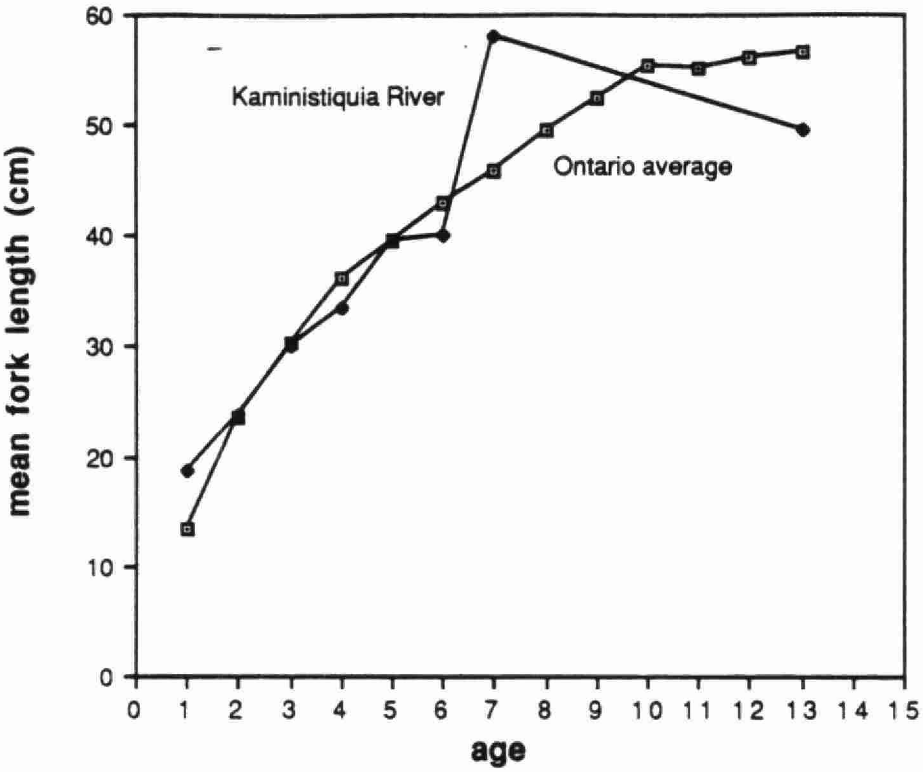


FIG. 11. Mean length at age for walleye from the Kaministiquia River and Ontario average (SPOF 15, 1983).

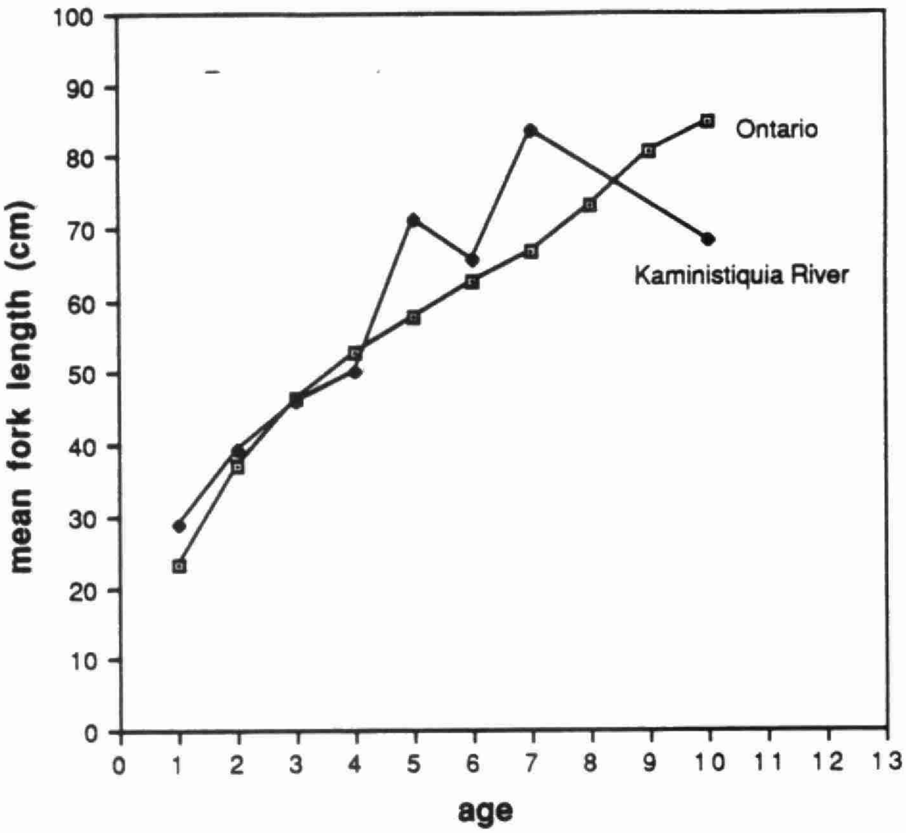


FIG. 12. Mean fork length at age for northern pike from the Kaministiquia River and Ontario average (SPOF 15, 1983).

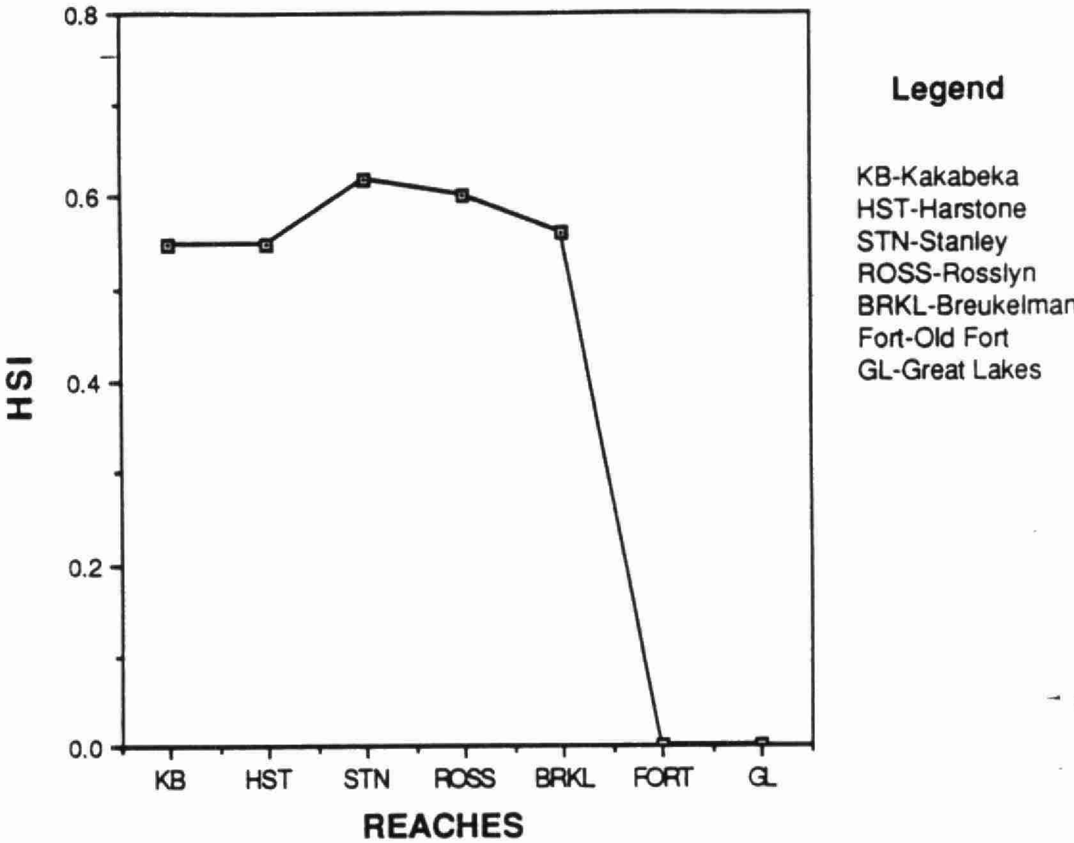


FIG. 13. Habitat suitability indices for rainbow trout for various reaches of the Kaministiquia R., Thunder Bay, Ontario in 1987.

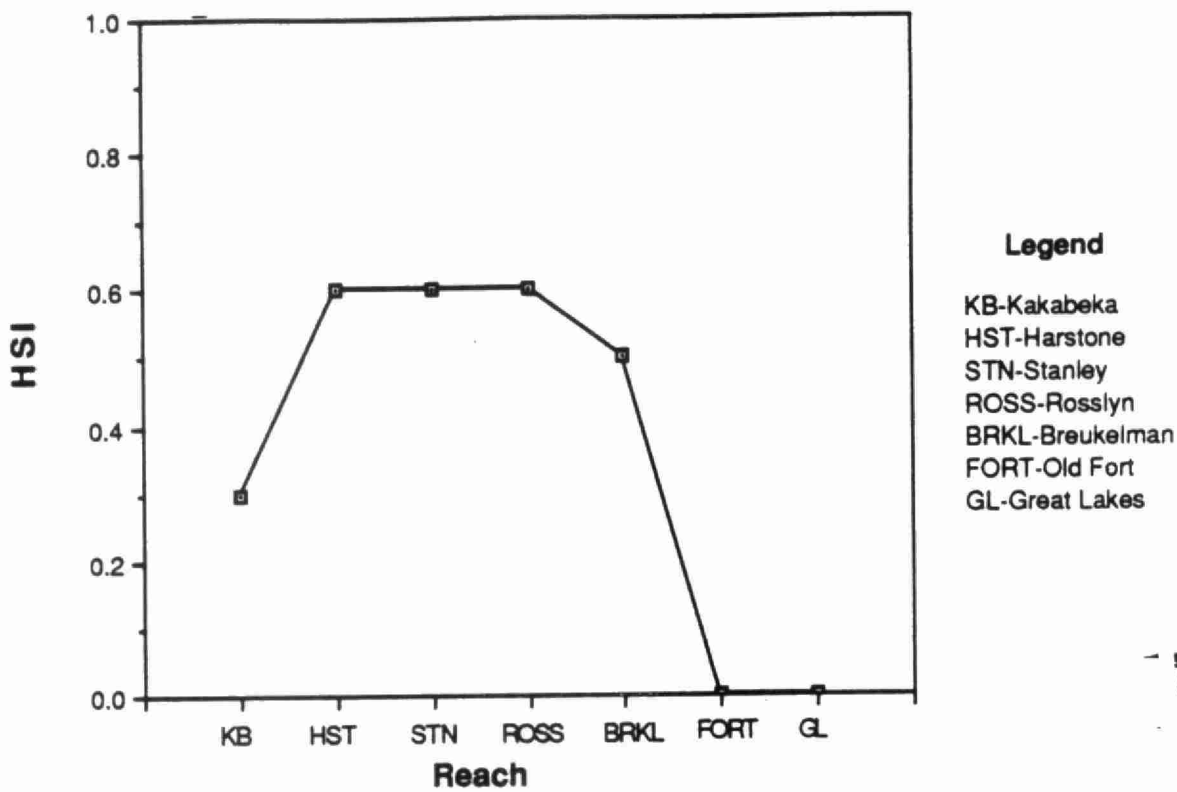


FIG.14. Chinook salmon habitat suitability indices for various reaches of the Kaminististiquia R., Thunder Bay, Ontario in 1987.

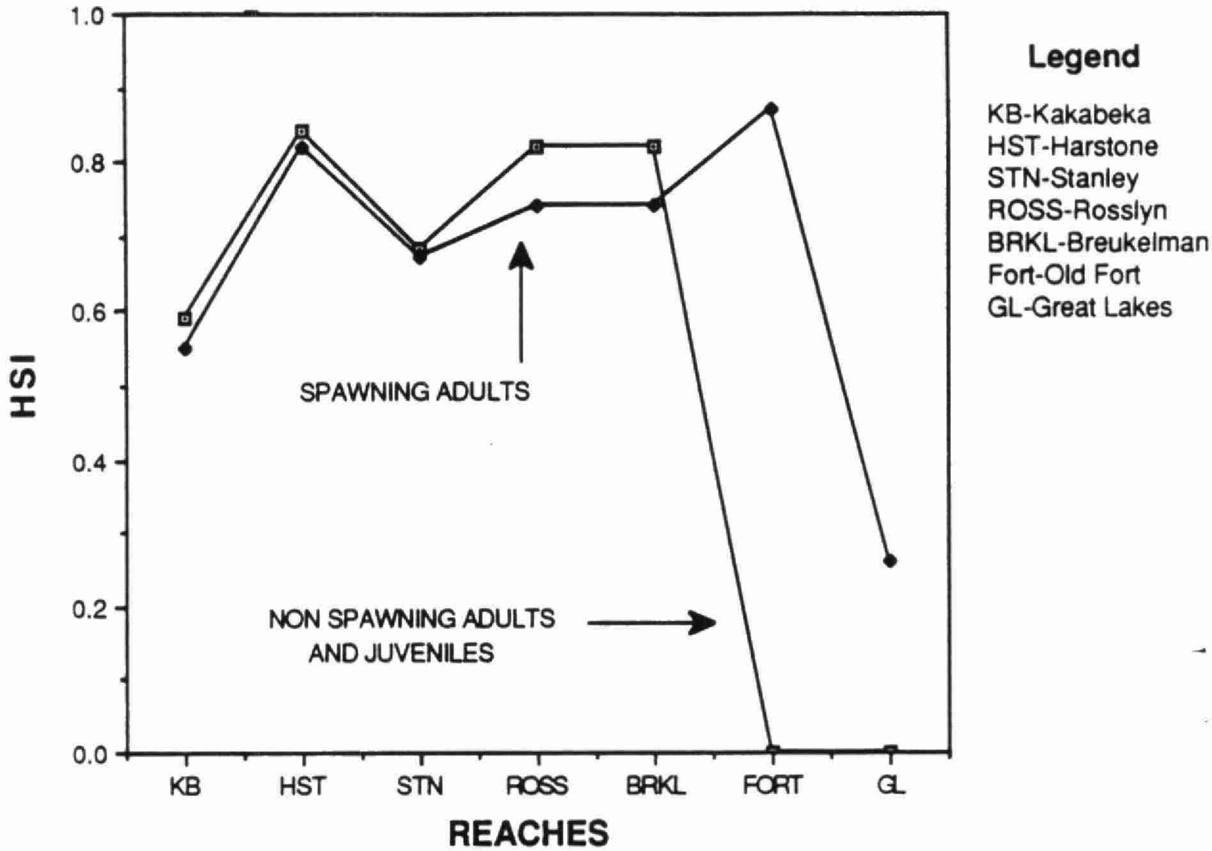
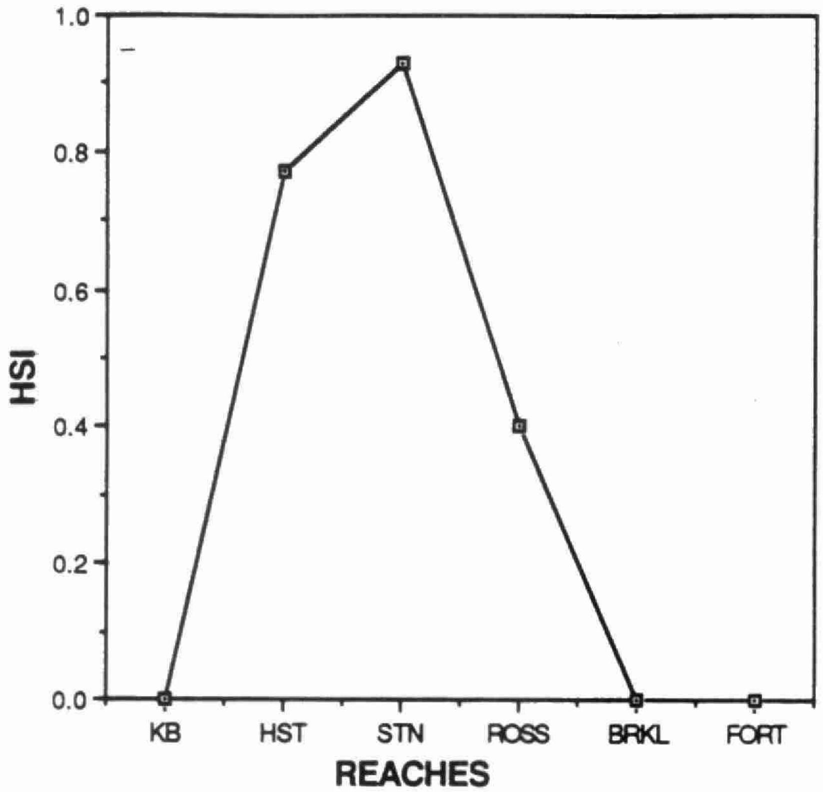


FIG. 15. Habitat suitability indices for spawning and non-spawning adult and juvenile white suckers for various reaches of the Kaministiquia R., Thunder Bay, Ontario in 1987.



Legend

KB-Kakabeka

HST-Harstone

STN-Stanley

ROSS-Rosslyn

BRKL-Breukelman

FORT-Old Fort

GL-Great Lakes

FIG. 16. Habitat suitability indices for the common shiner for various reaches of the Kaministiquia R., Thunder Bay, Ontario in1987

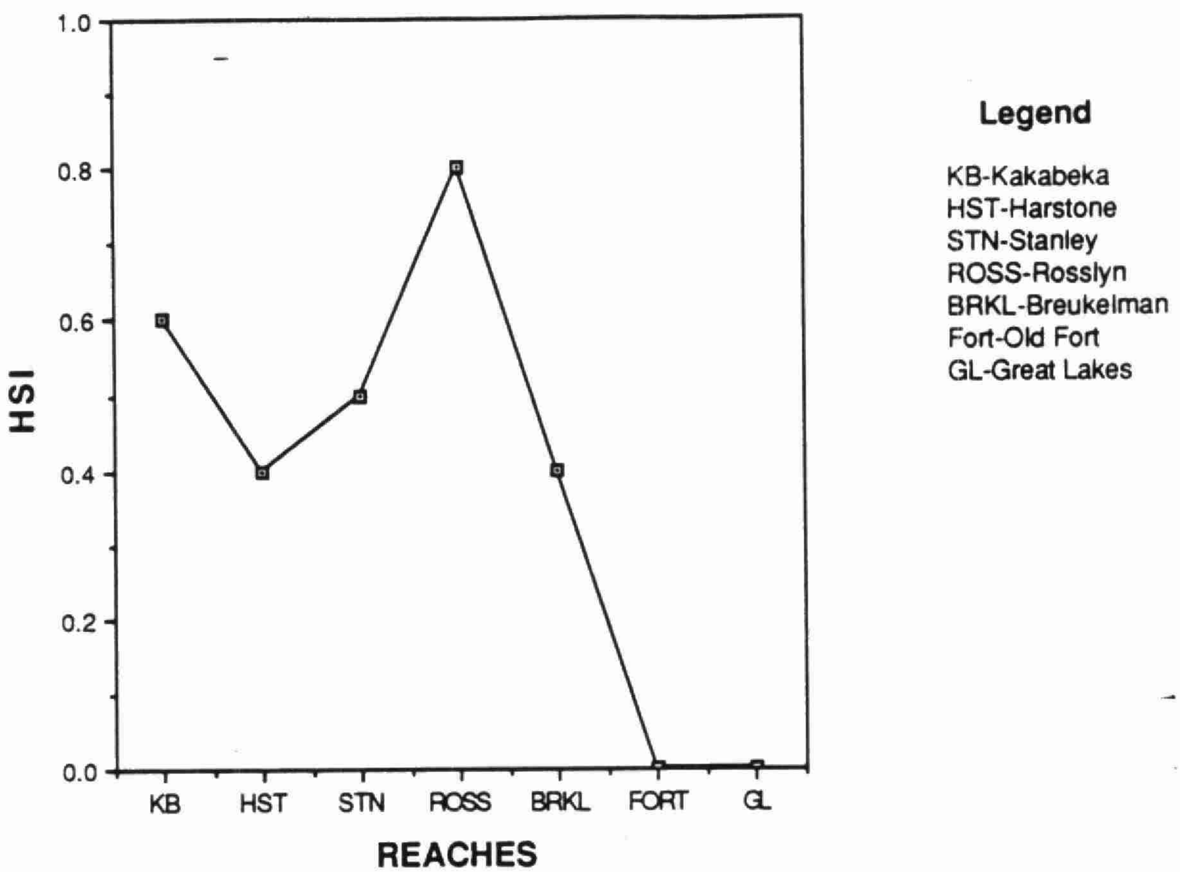


FIG. 17. Habitat suitability indices for longnose dace for various reaches of the Kaminstiquia R., Thunder Bay, Ontario in 1987.

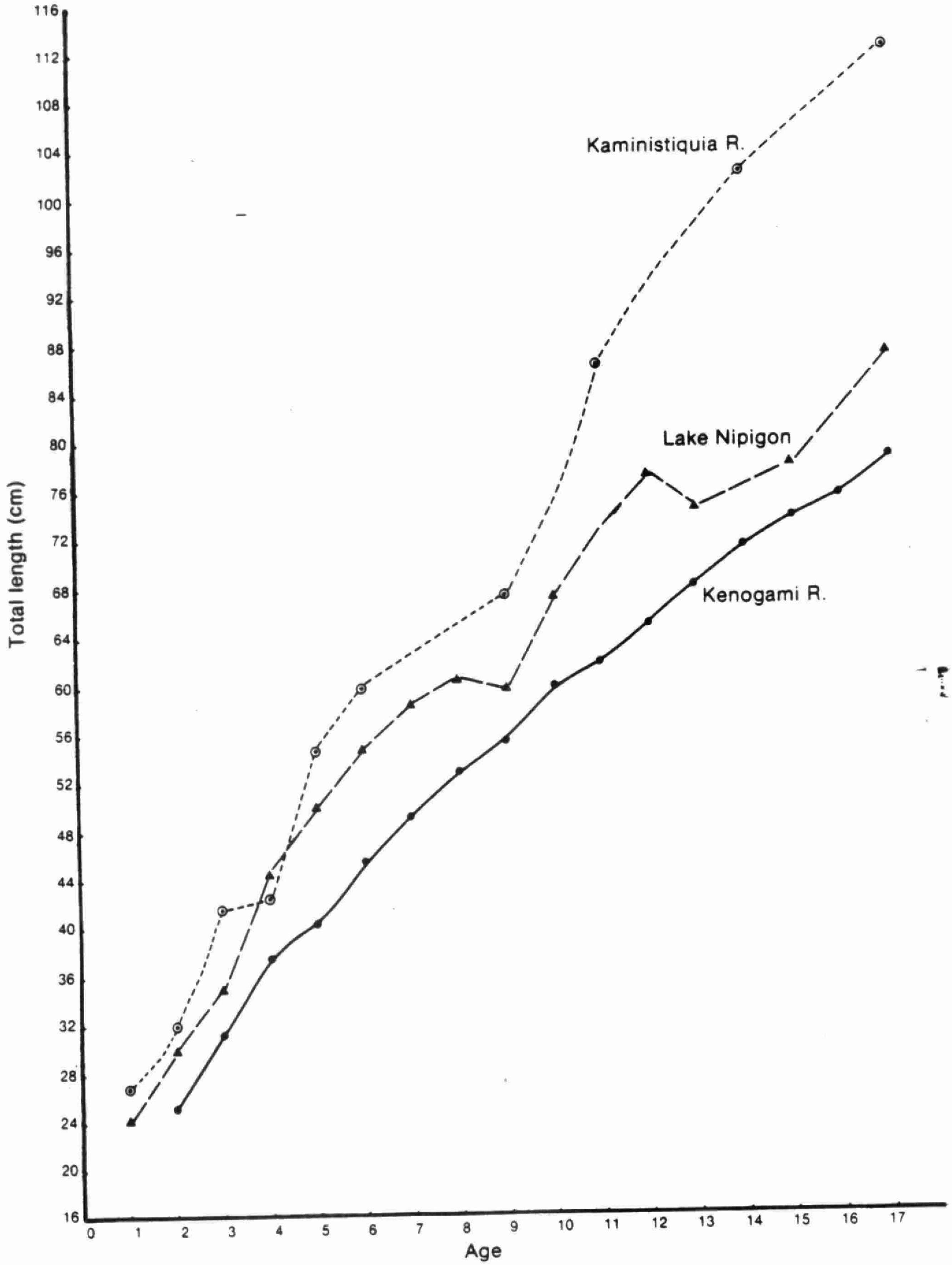


Fig. 18. Mean total length (cm) at age for lake sturgeon from three locations in Northwestern Ontario.

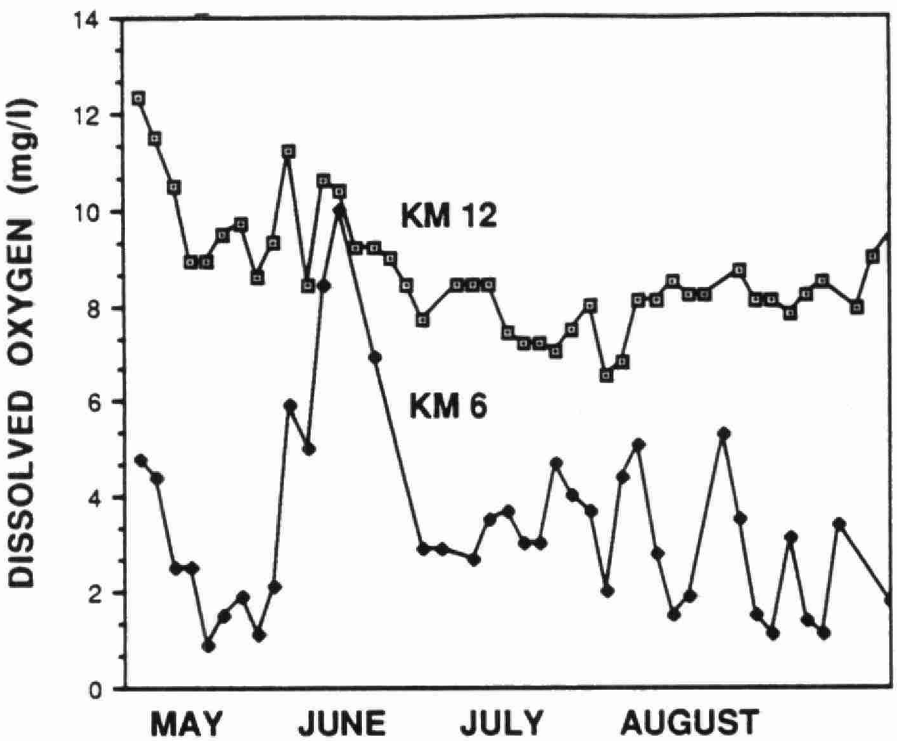


FIG. 19. Daily mean dissolved oxygen (mg/l) at km 6 and 12 in the Kaministiquia River from April to August 1987.

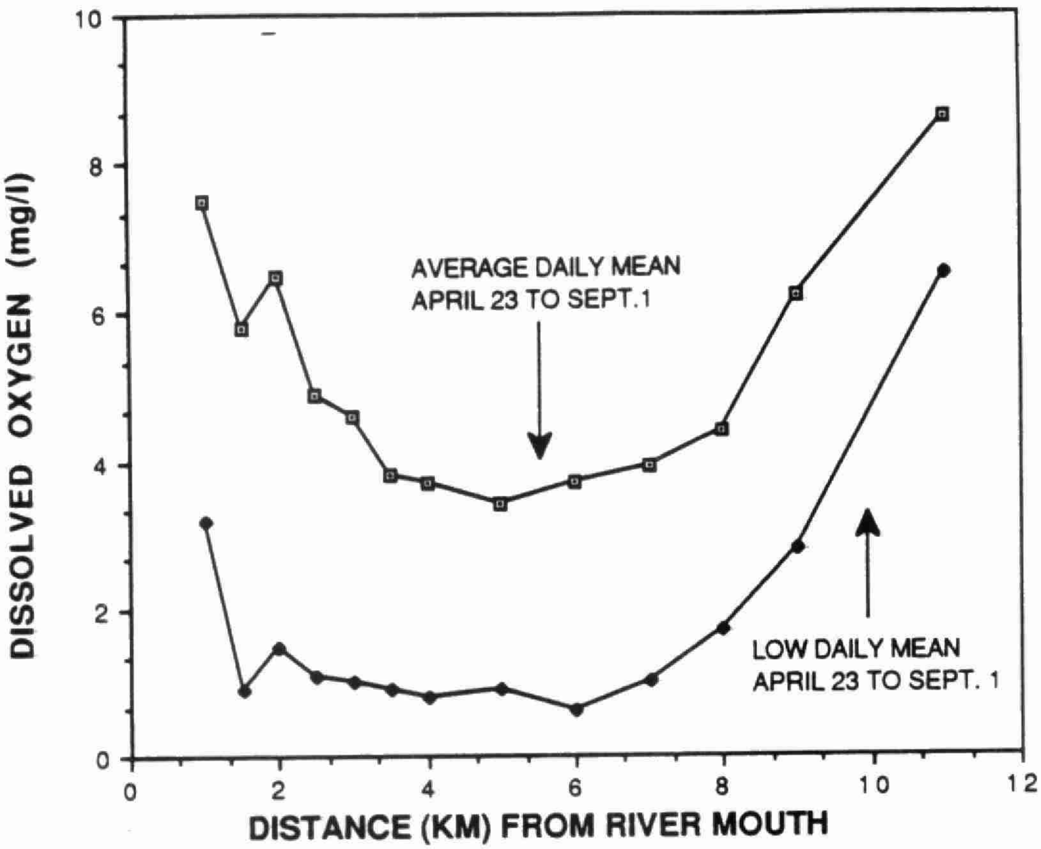


Fig. 20 Daily mean and low daily mean dissolved oxygen (mg/l) recorded from April 23 to September 1 in the Kaministiquia River from the mouth (km 1) upstream to km 14.

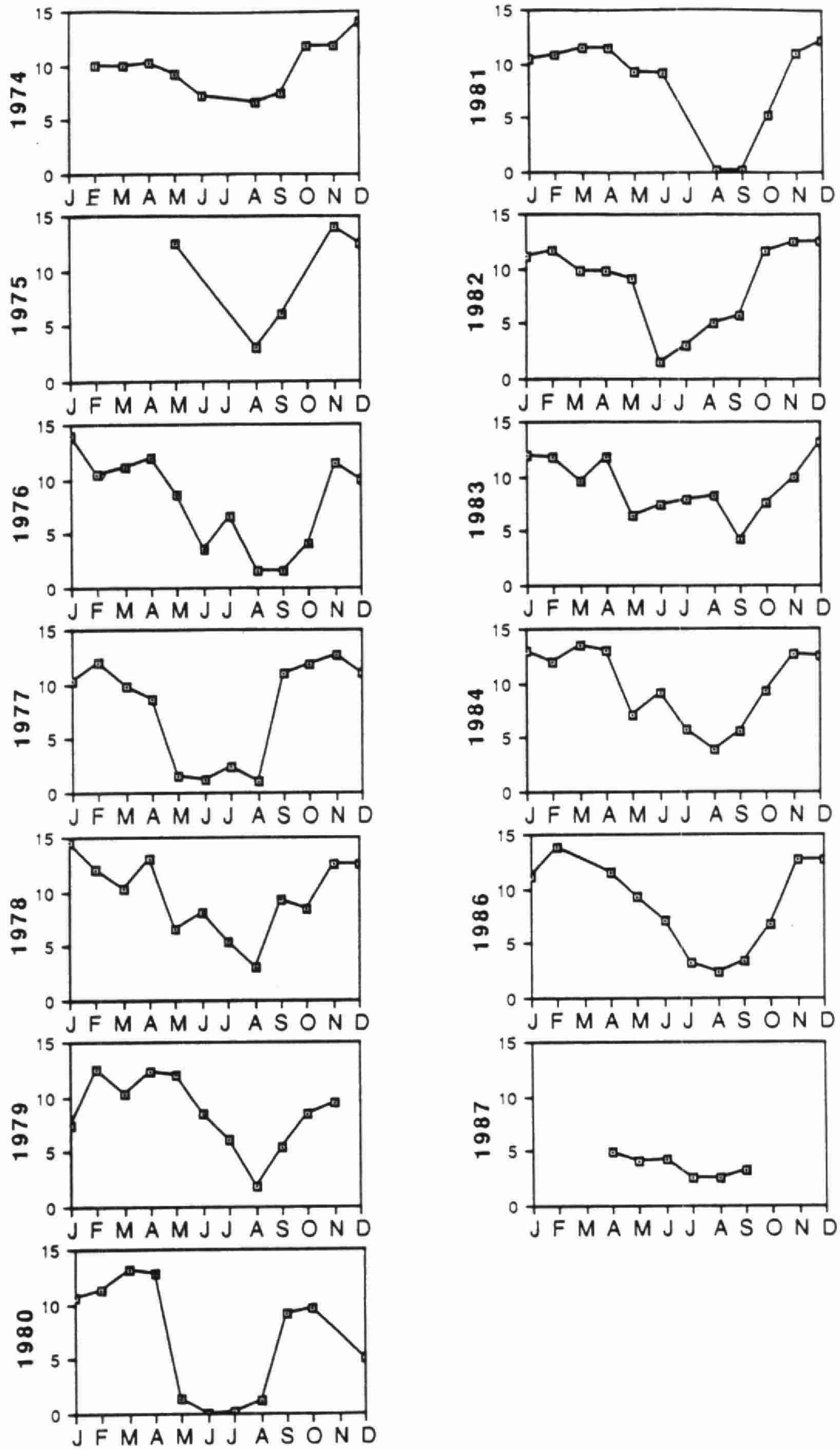


Fig. 21. Mean monthly dissolved oxygen readings taken at mid-depth at km 4, Kaministiquia R., Thunder Bay, Ontario from April to November, 1974 to 1987.

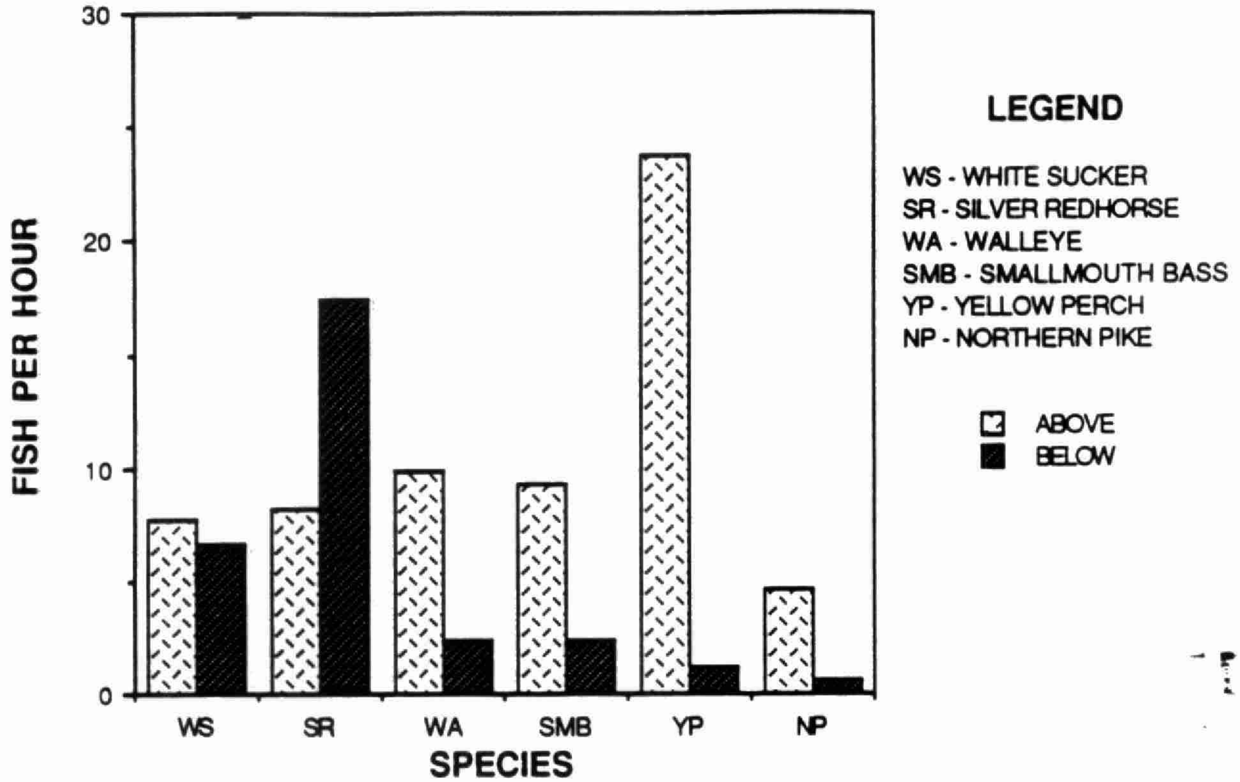


FIG. 22. Catch per unit of effort of 6 fish species captured with an electrofishing boat at night below and above the Canadian Pacific Forest Products Mill on the Kaministiquia R., Thunder Bay, Ontario in 1987.

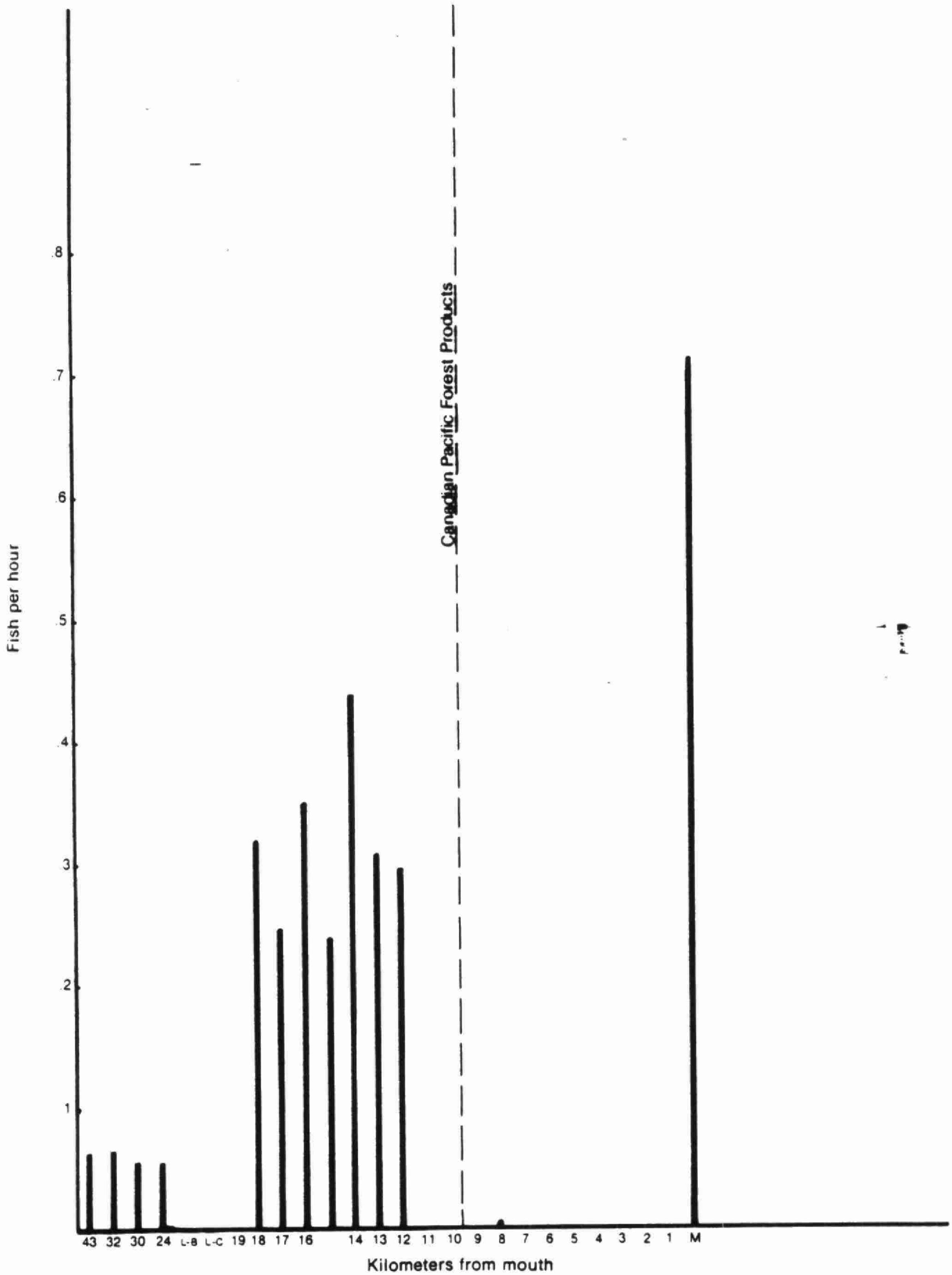


Fig. 23. CPUE's for walleye caught with index gillnets from the Kaminististiquia R., 1987.

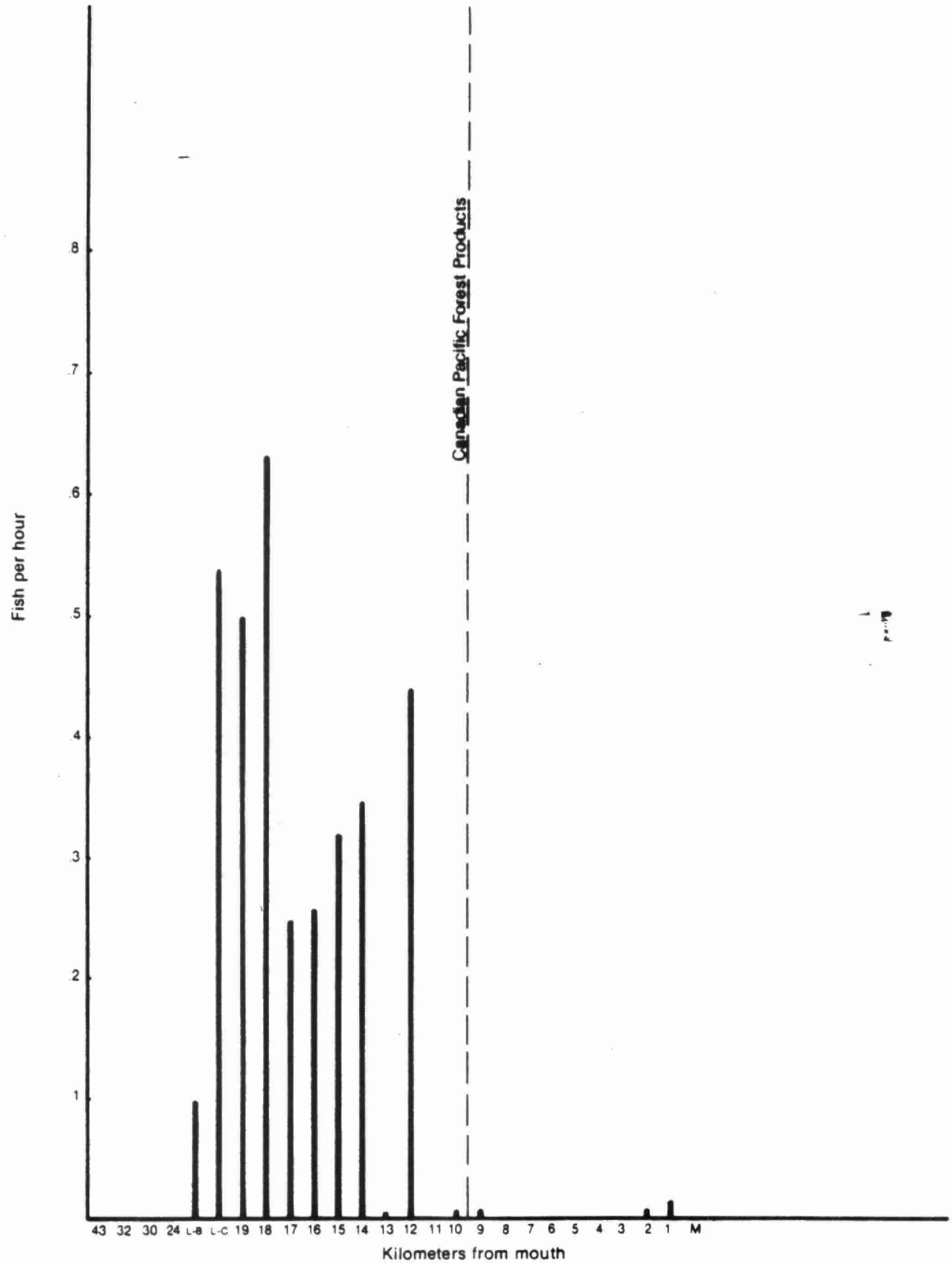


Fig. 24. CPUE's for yellow perch caught with index gillnets from the Kaministiquia R., 1987.

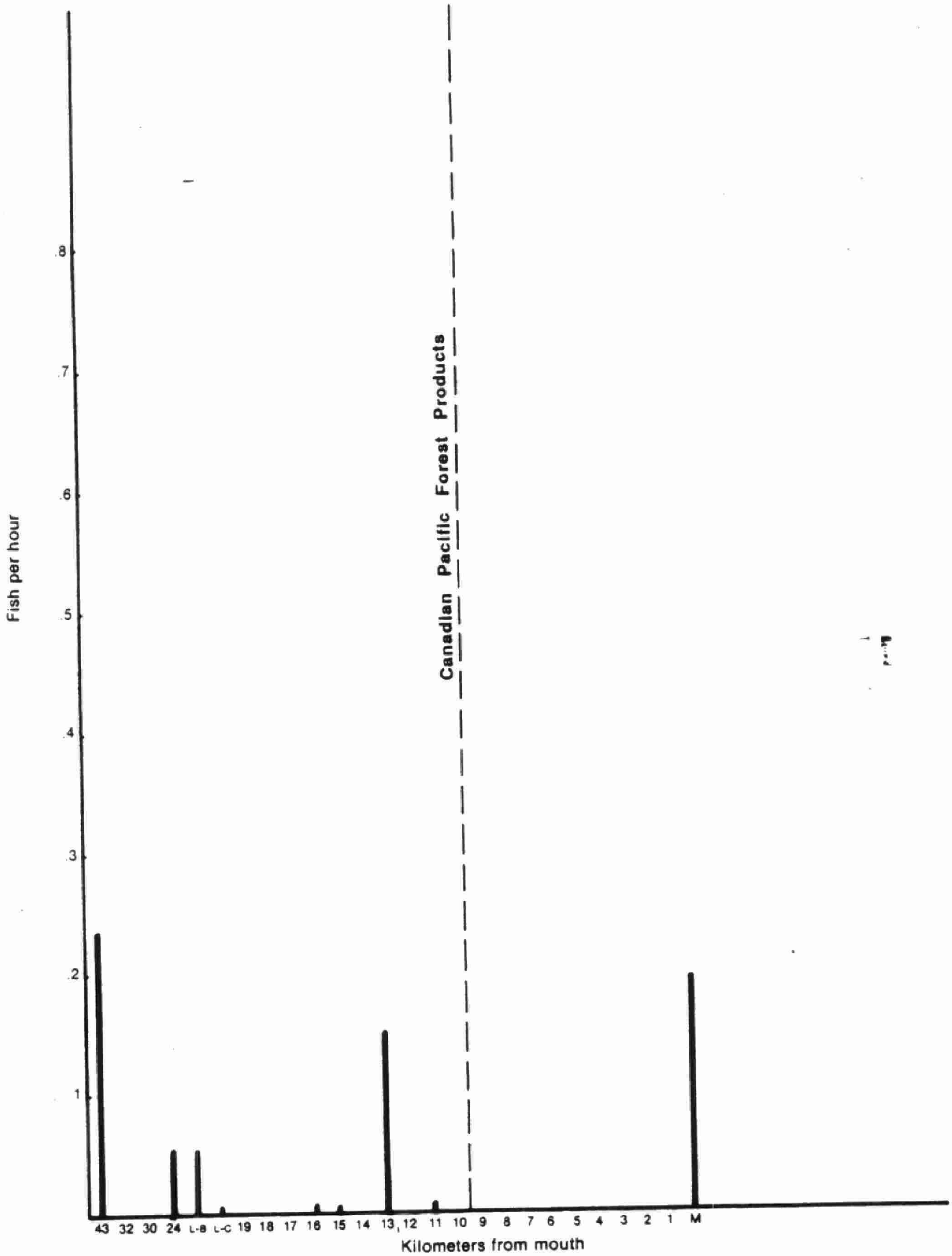


Fig. 25. CPUE's for northern pike caught with index gillnets from the Kaministiquia R., 1987.

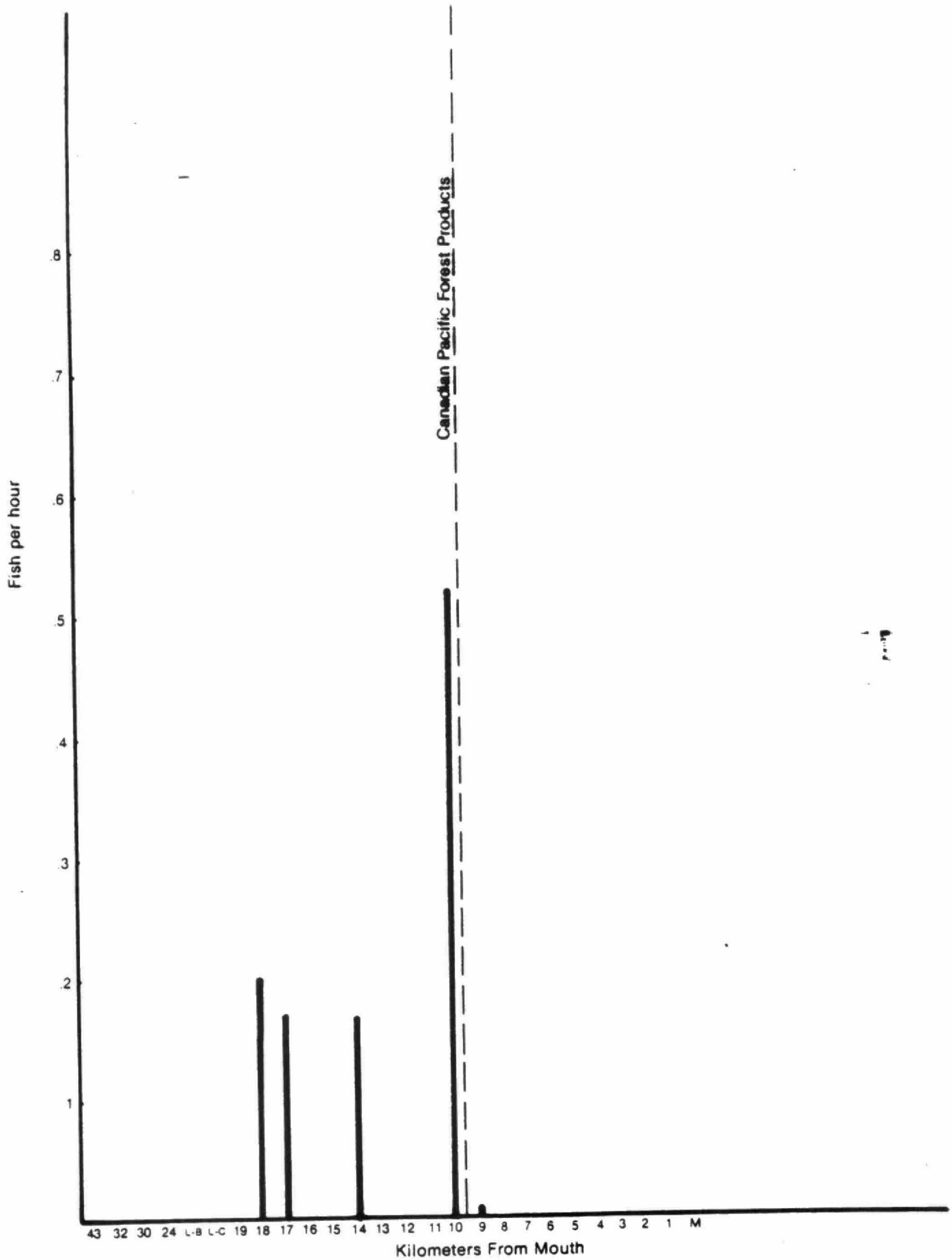
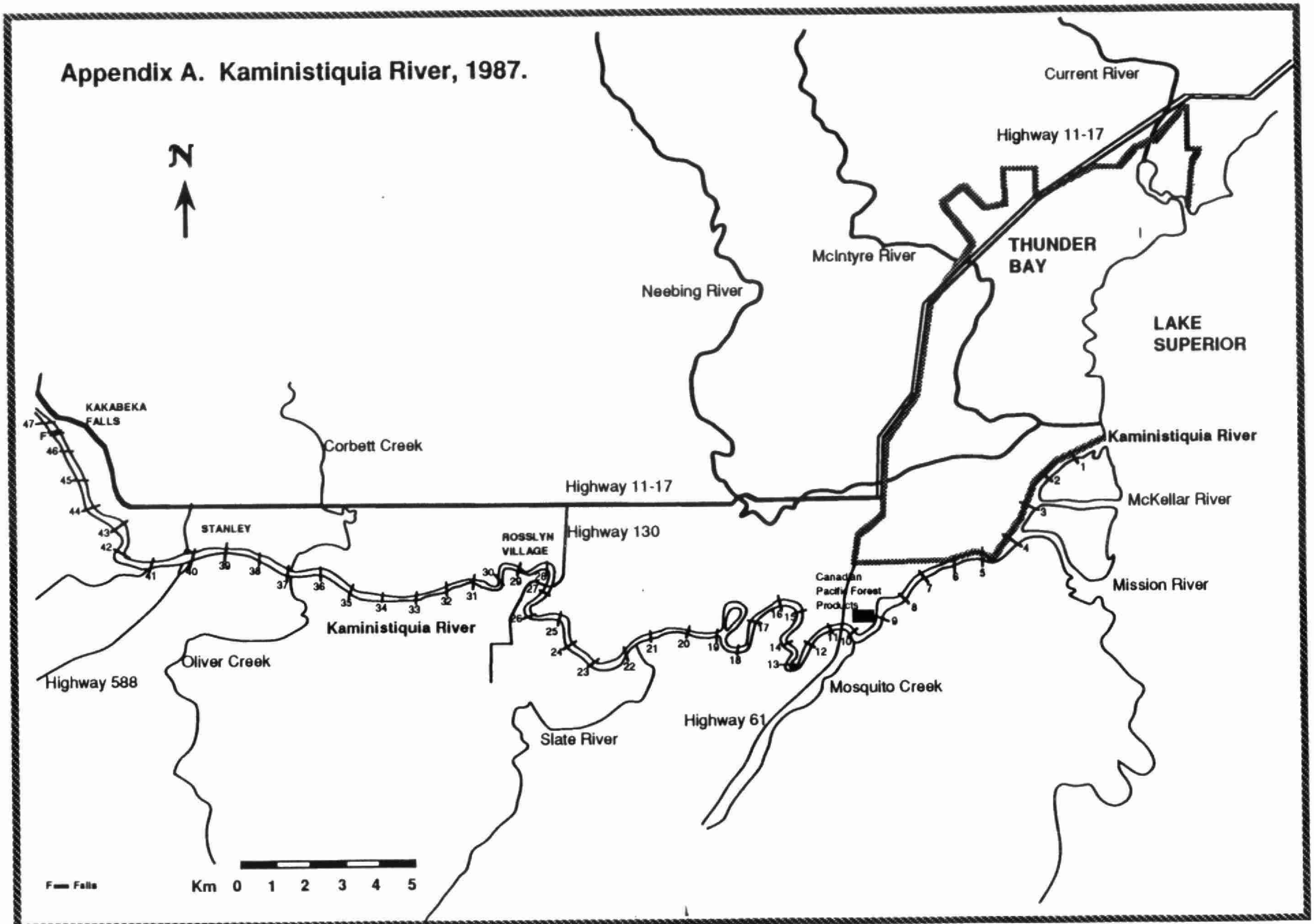


Fig. 26. CPUE's for lake sturgeon caught with index gillnets from the Kaministiquia R., 1987.

10.0 APPENDICES

Appendix A. Kaministiquia River, 1987.



Appendix B. Definition of terms relating to river morphology and instream features. (Refers to legends in appendices B-1 to B-47).

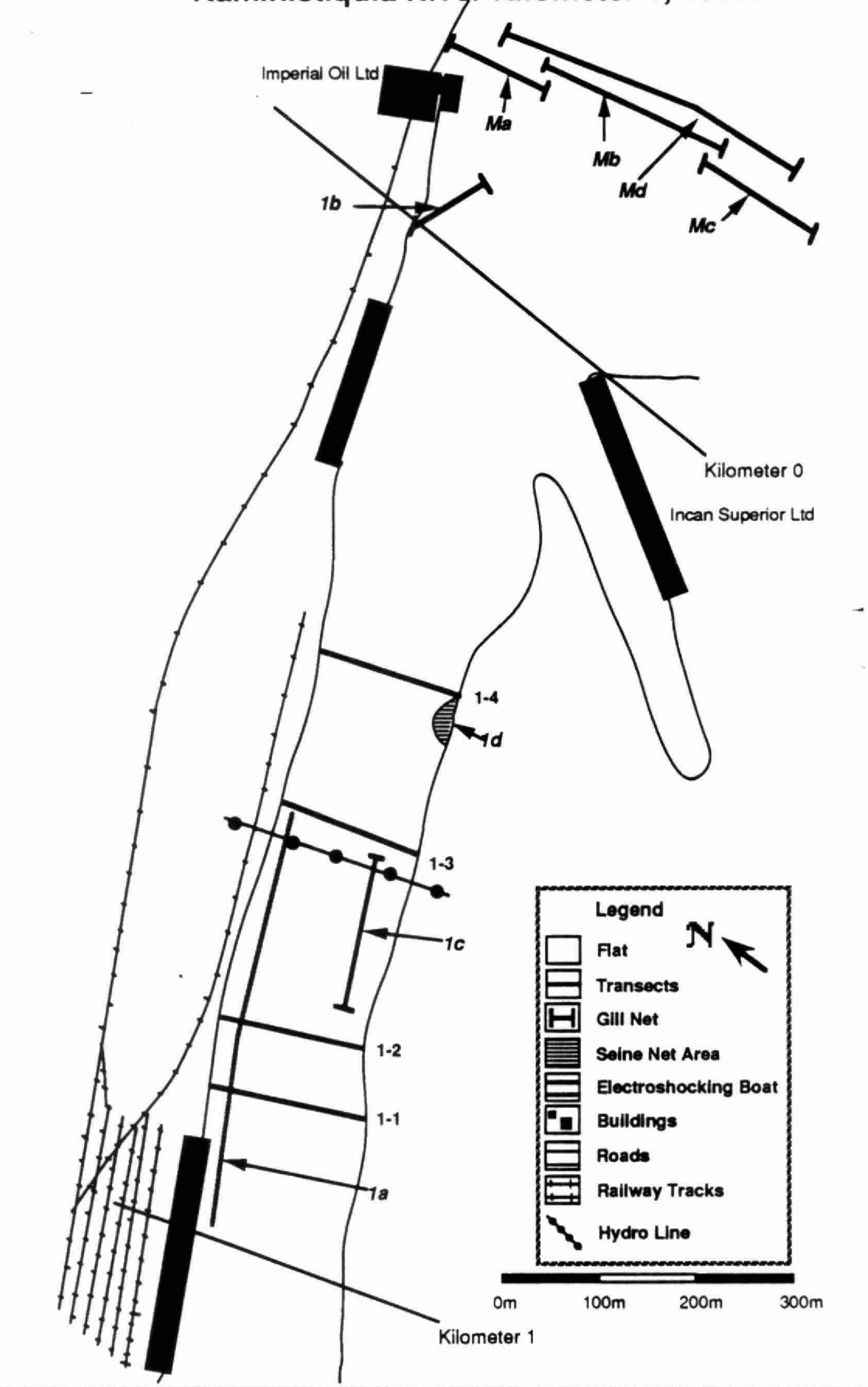
1. River morphology (from: Aquatic Habitat Inventory Surveys, MNR 1987)

Riffle: Shallow, swift flowing sections of river where the water's surface is broken and the substrate often breaks the surface. From 1 cm to 20 cm in depth.
Pool: A deep, slow moving section of river having silt, sand or debris on the bottom.
Rapids: A robust form of a riffle, in which the river cascades quickly over rock and boulders causing the water to be turbulent (white water). Rapids are longer and deeper than riffles and generally not easily waded.
Run: A deep, swift flowing section of river usually having a rubble gravel or boulder substrate.
Flat: A shallow, slow moving section of river having a rock, silt or fine sand substrate.
Bars: Deposits of water borne substrates, usually sand and gravel, which may be either submerged or emerged depending upon the water level of the river.
Channels: The cross-sectional area of the river through which the greatest volume of water flows.
Tributaries and springs: These account for relatively large additions of water to the river. Springs are less obvious than tributaries and occasionally have discoloured water.
Rip Rap: Blasted rock used to stabilize eroding river banks.
Rock: Boulders over 1m in diameter.
Macrophytes: Large rooted aquatic plants.

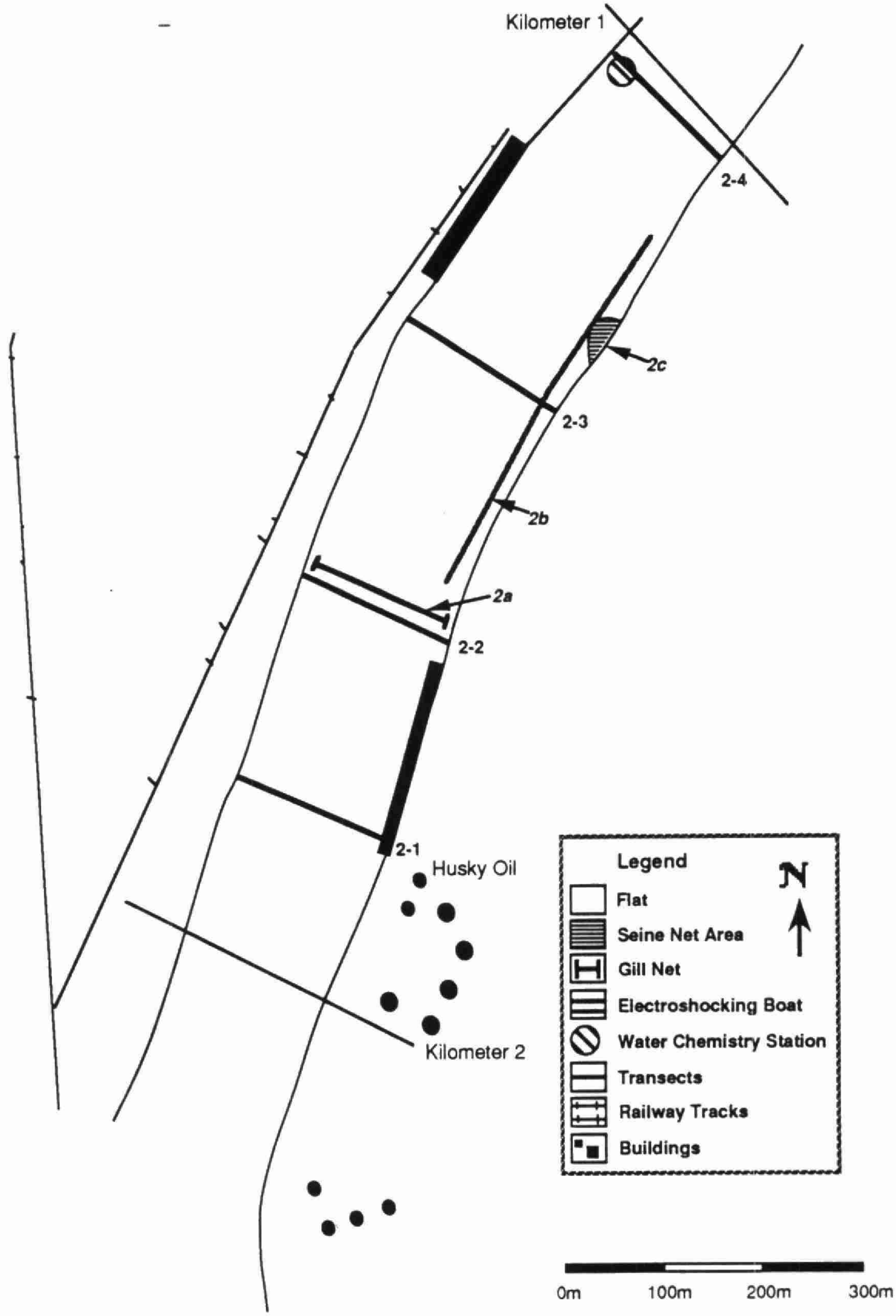
2. Substrate classification (based on Hynes, 1970)

Bedrock: Exposed rock with no overburden.
Boulder: Rock over 25 cm in diameter.
Rubble: Rock between 8 cm and 25 cm.
Gravel: Rock between 2 mm and 8 cm.
Sand: Crystalline rock < 2 mm in diameter; palpable as grit.
Silt: Inorganic material of various origins finer than sand.
Clay: Inorganic material with a greasy feel and no apparent structure.
Muck: Soft organic material composed of silt and clay often containing appreciable amounts of organic material; no sand or gravel present.
Detritus: Organic material composed of leaves, sticks, twigs or decayed aquatic plants.
Ooze: Organic material having a gelatinous-like texture.

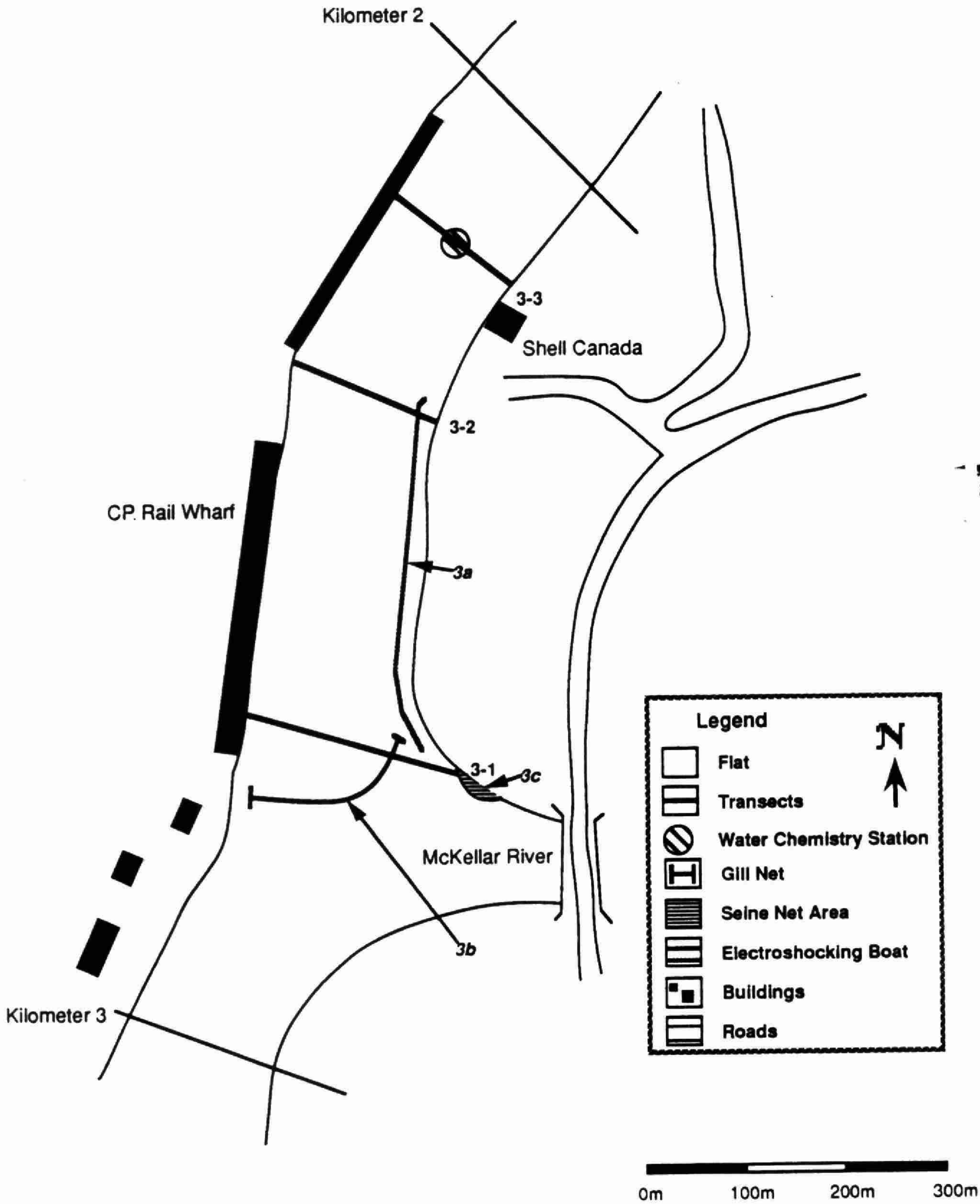
Appendix B-1. Instream Features and Collection Stations Kaministiquia River Kilometer 1, 1987.



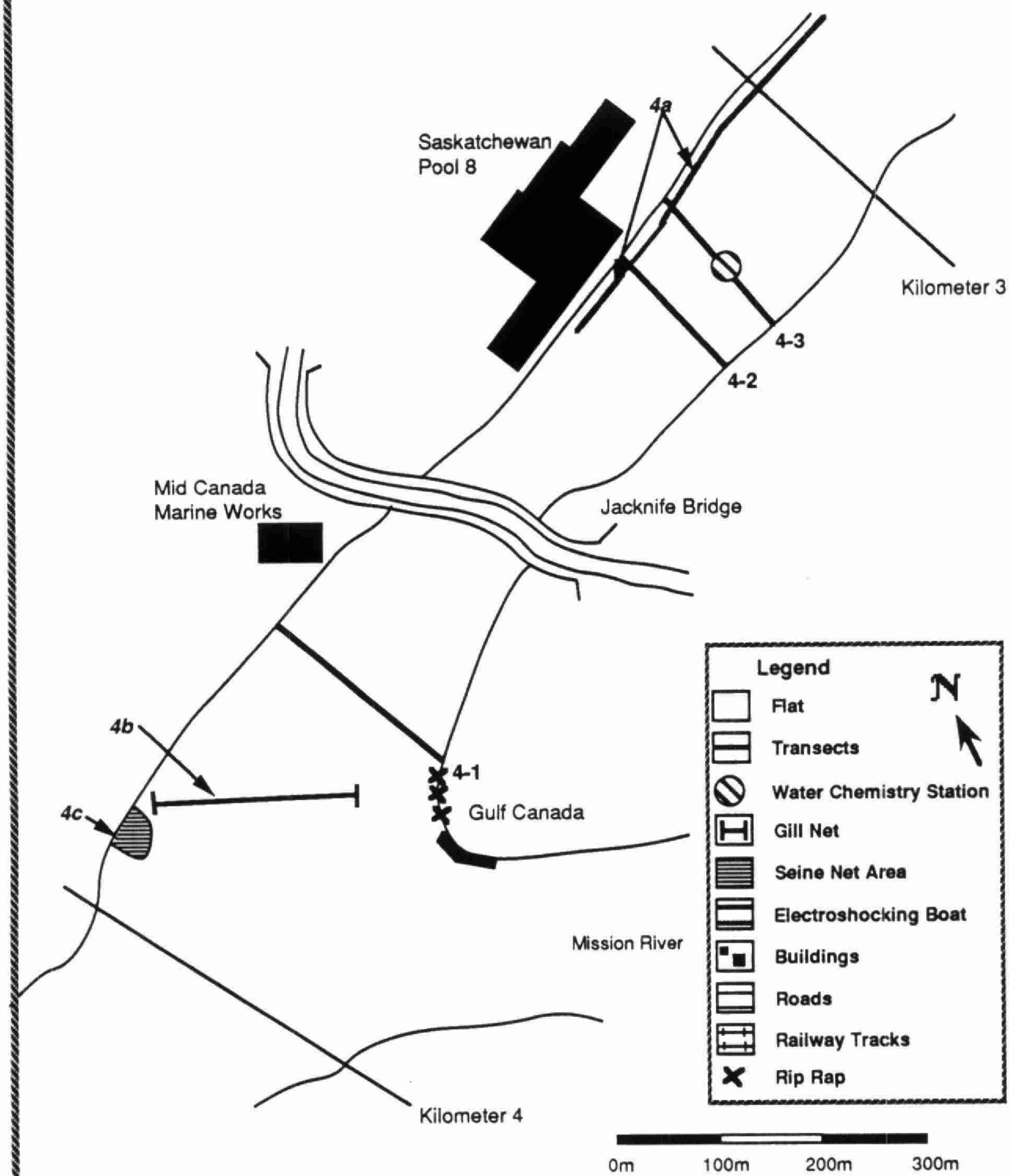
Appendix B-2. Instream Features and Collection Stations Kaministiquia River Kilometer 2, 1987.



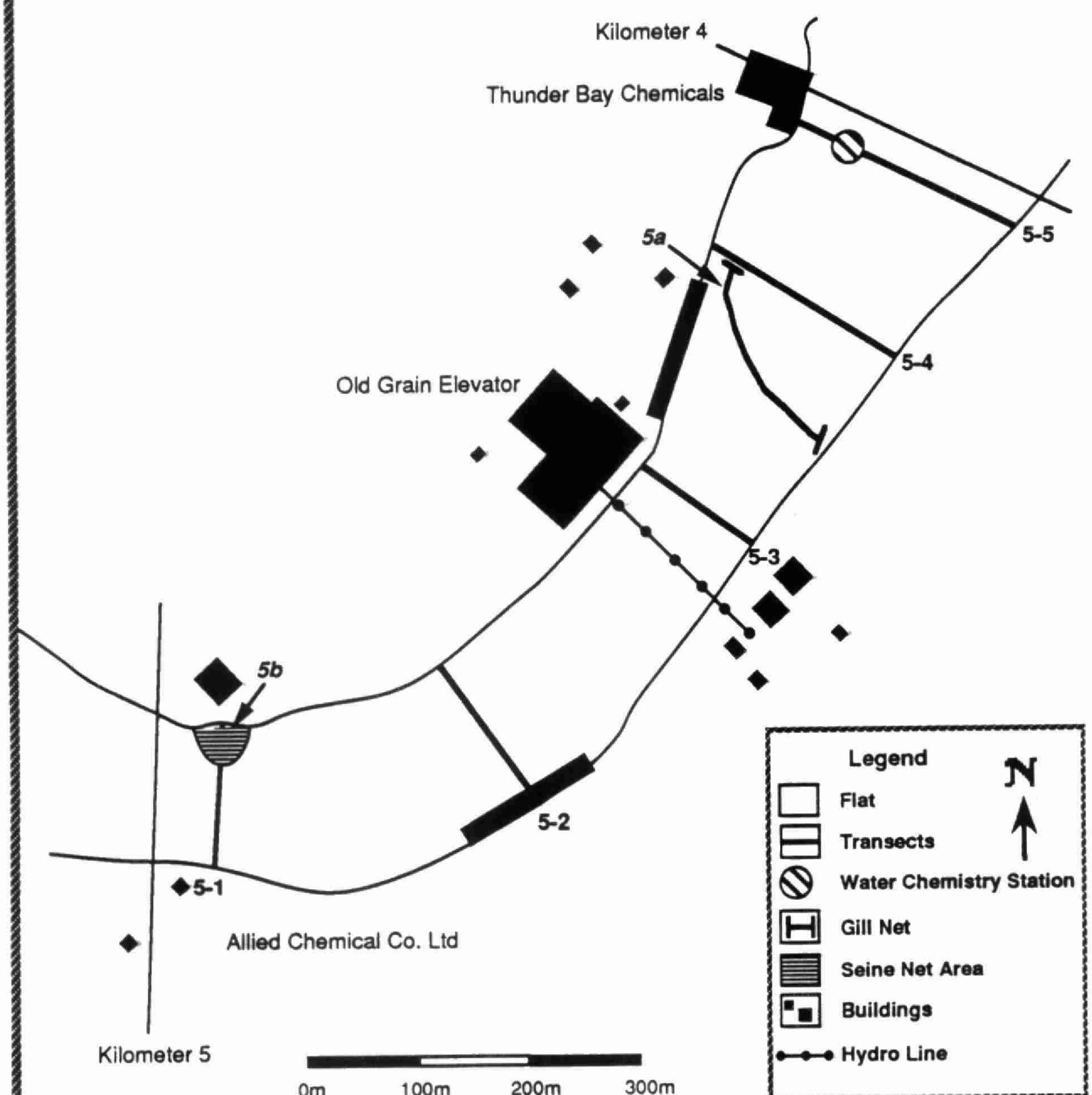
Appendix B-3. Instream Features and Collection Stations, Kaministiquia River Kilometer 3, 1987.



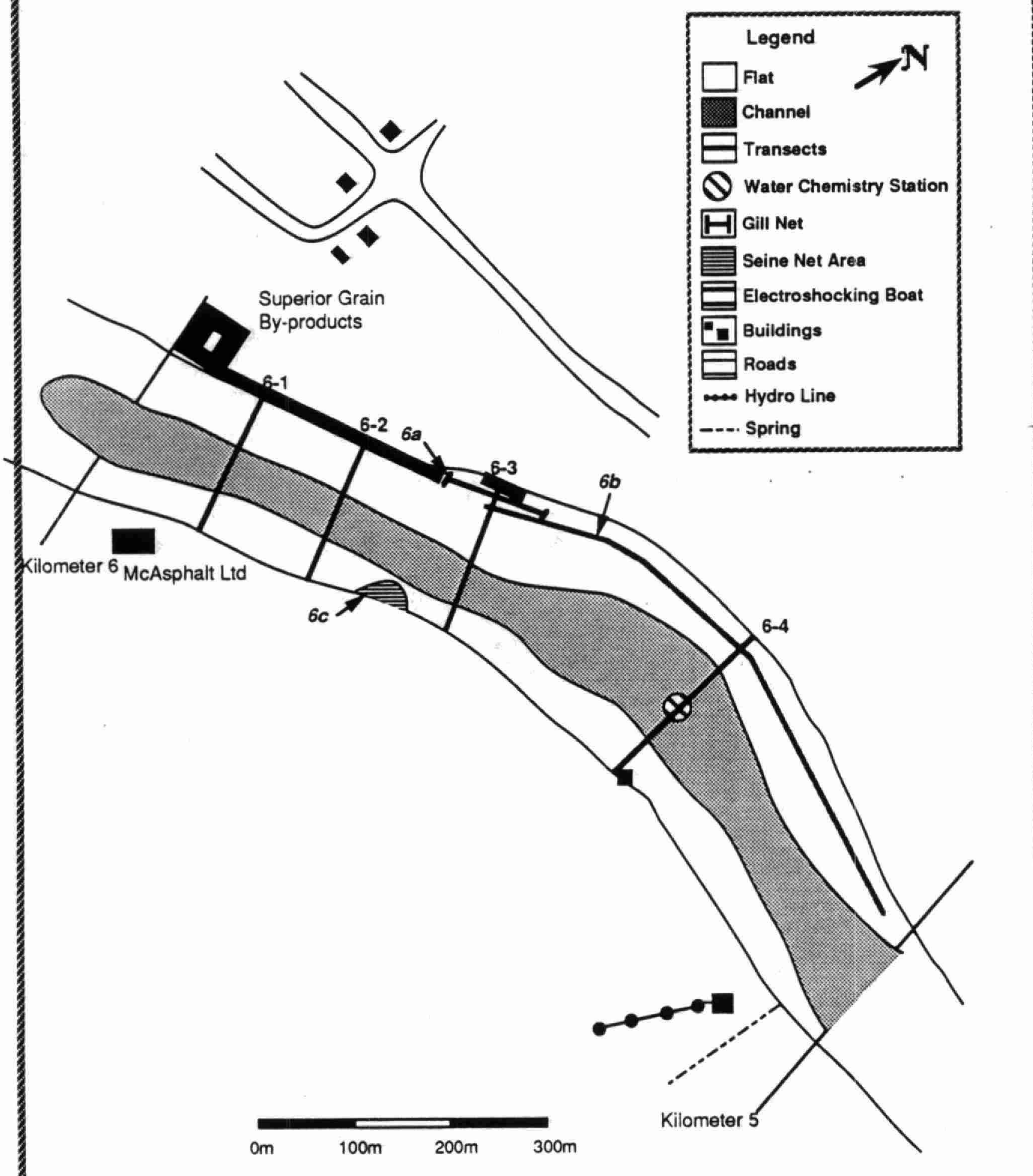
Appendix B-4. Instream Features and Collection Stations Kaministiquia River Kilometer 4, 1987.



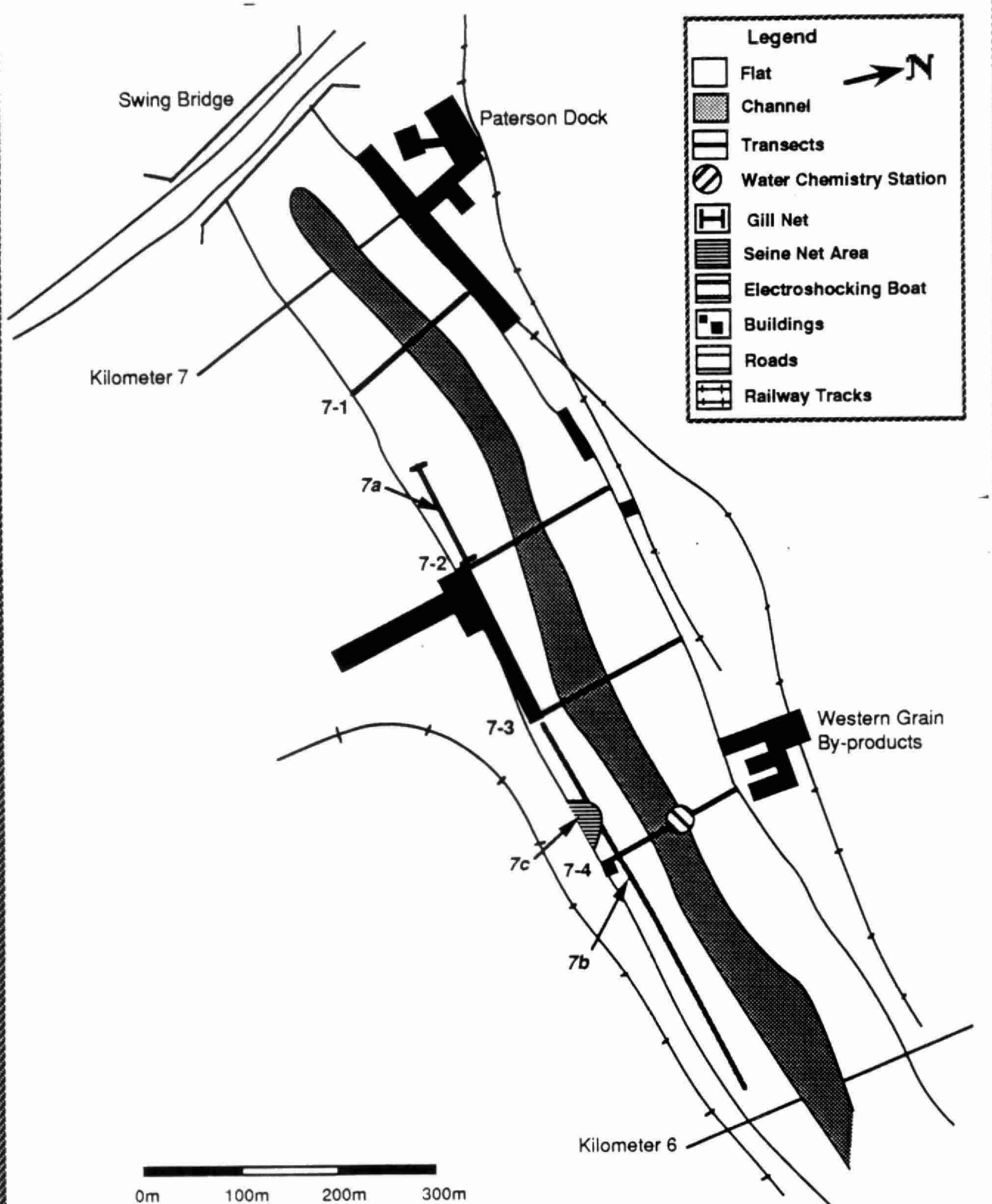
Appendix B-5. Instream Features and Collection Stations Kaministiquia River Kilometer 5, 1987.



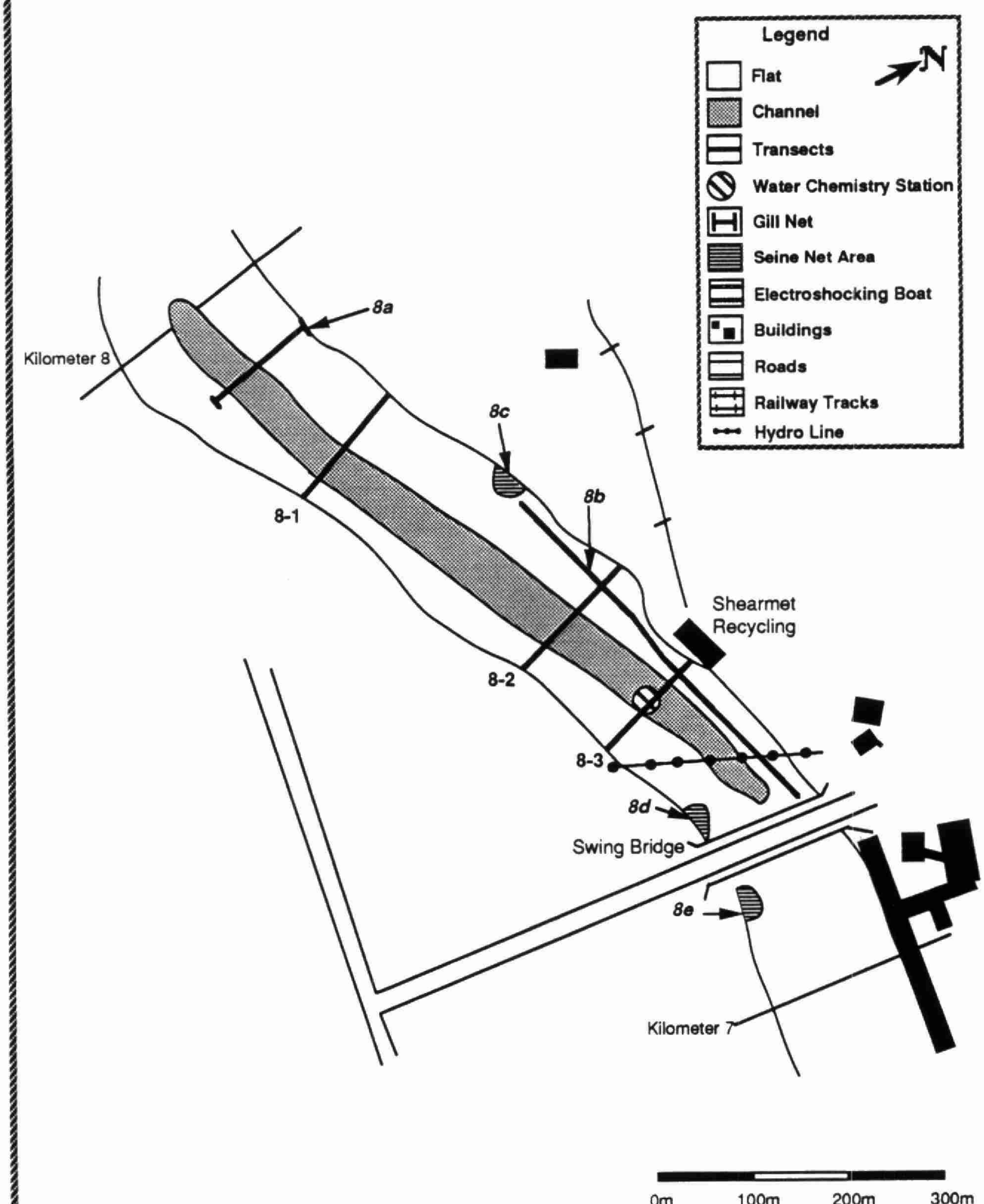
Appendix B-6. Instream Features and Collection Stations Kaministiquia River Kilometer 6, 1987.



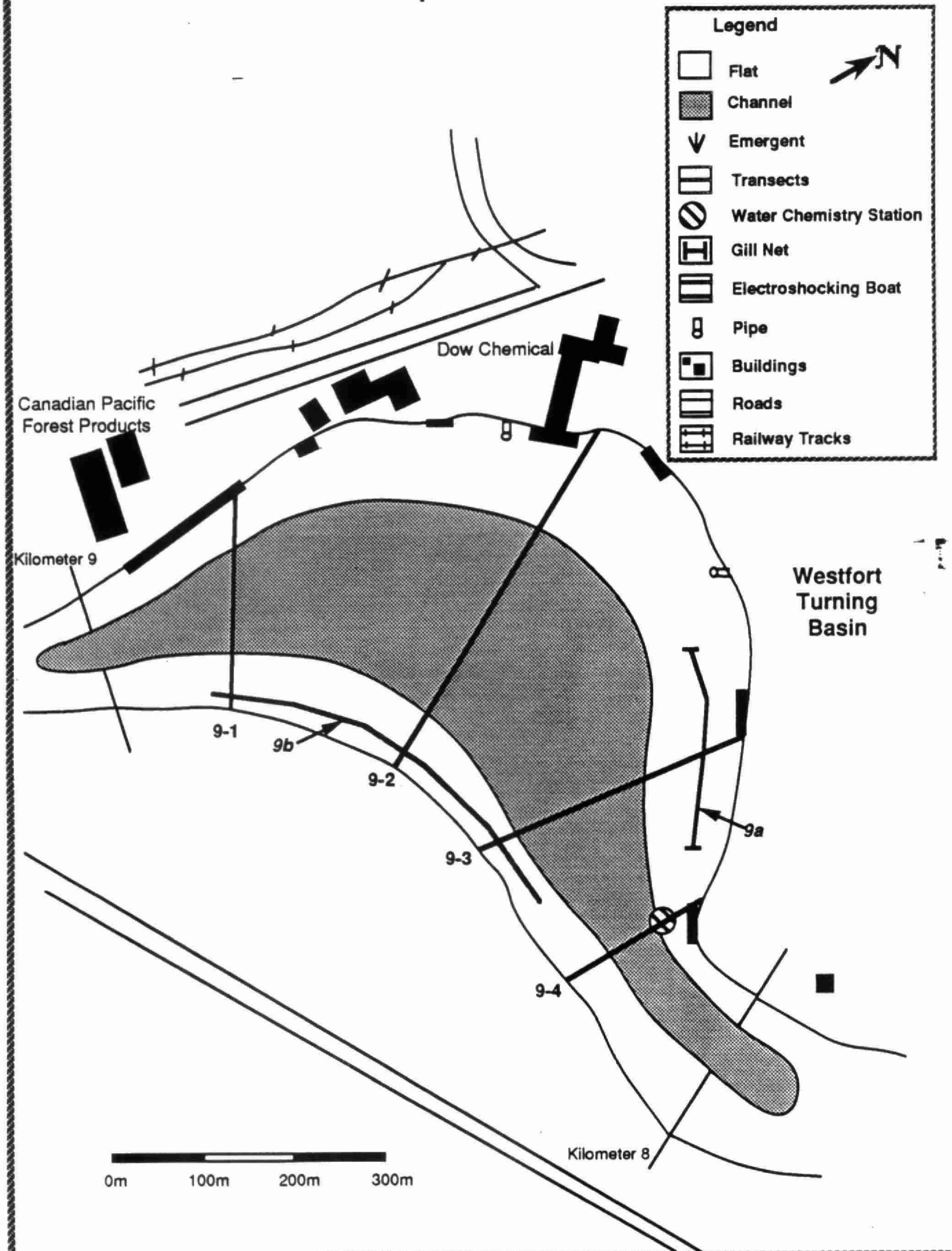
Appendix B-7. Instream Features and Collection Stations Kaministiquia River Kilometer 7, 1987.



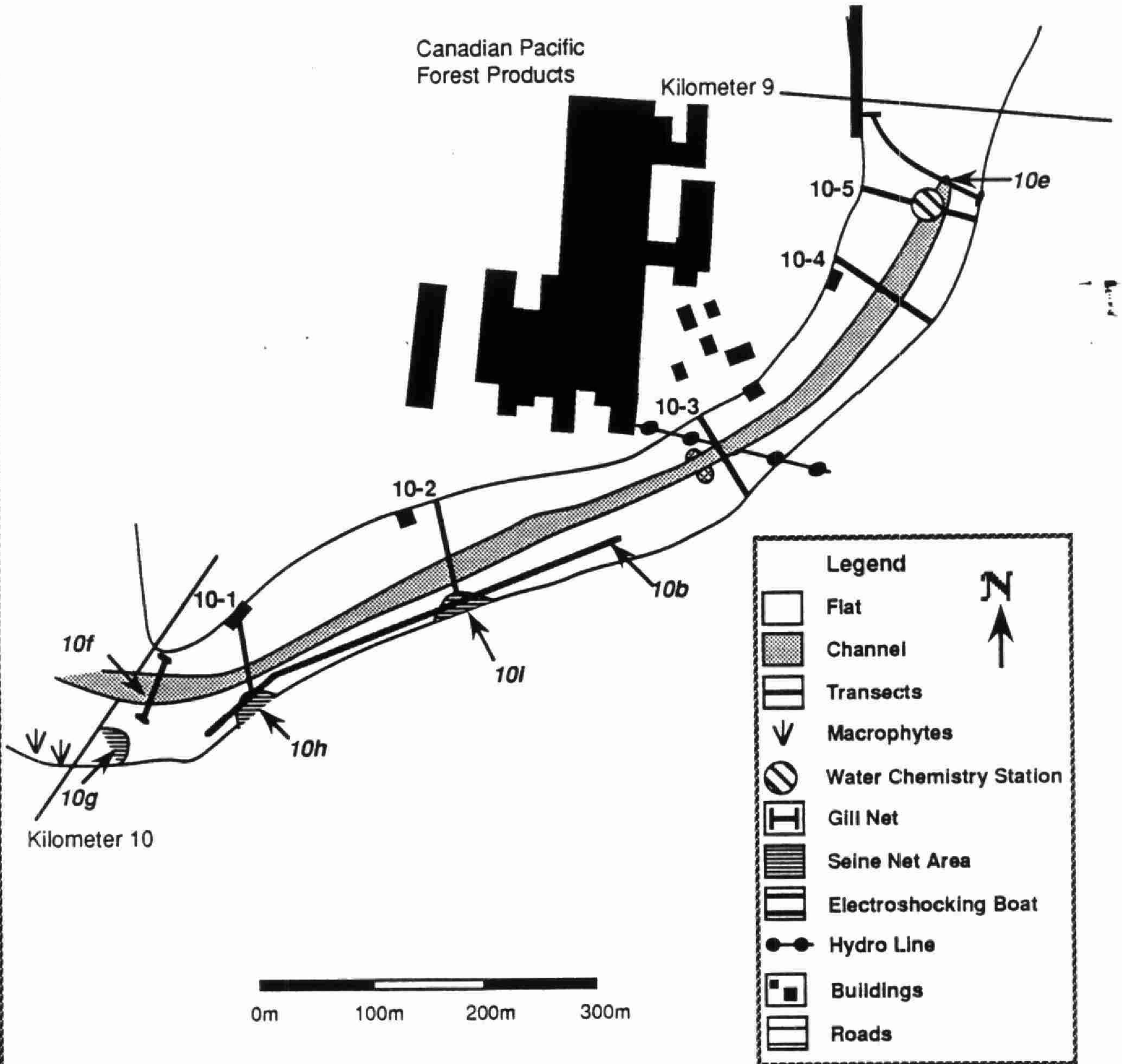
Appendix B-8. Instream Features and Collection Stations Kaministiquia River Kilometer 8, 1987.



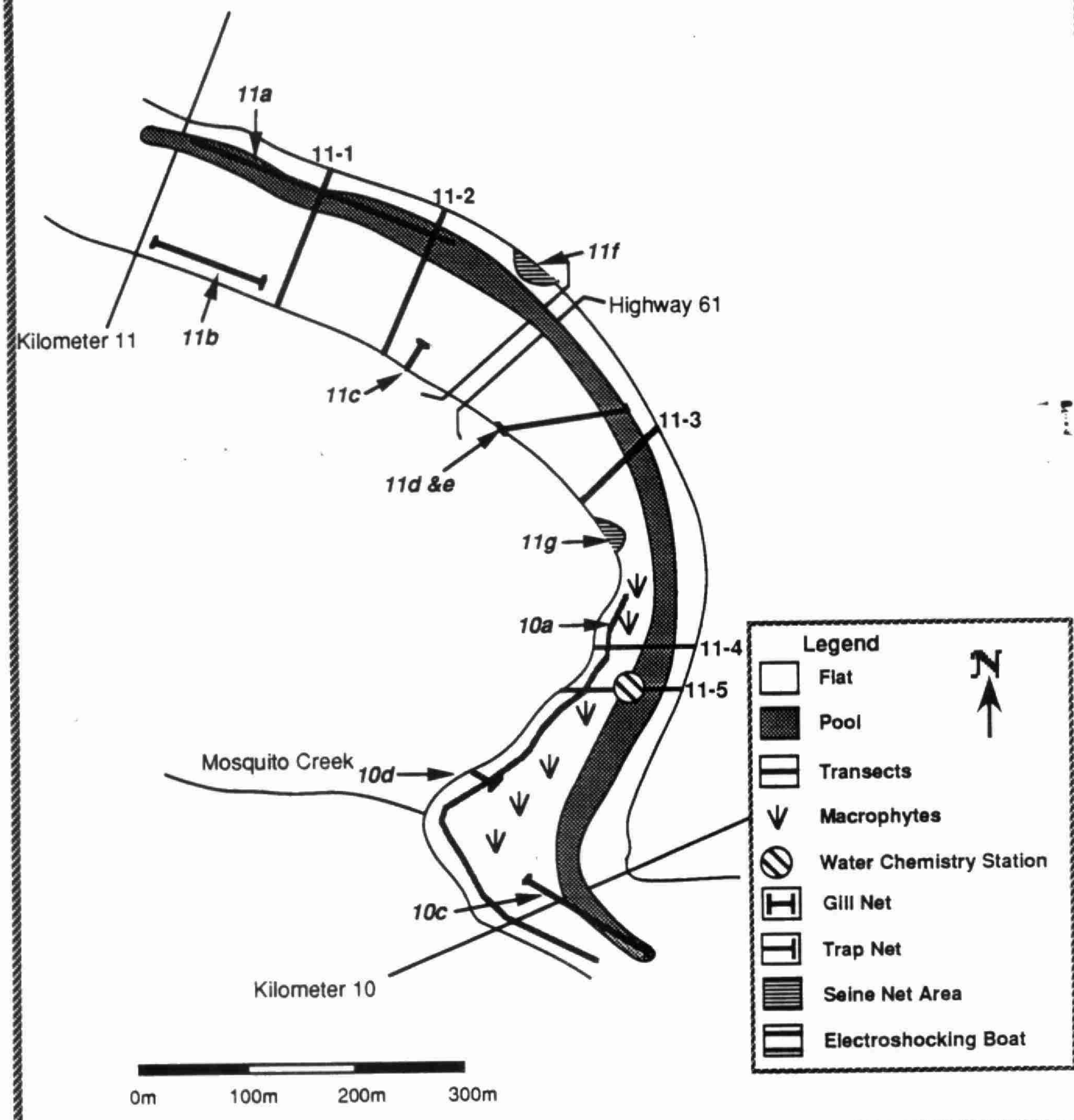
Appendix B-9. Instream Features and Collection Stations Kaministiquia River Kilometer 9, 1987.



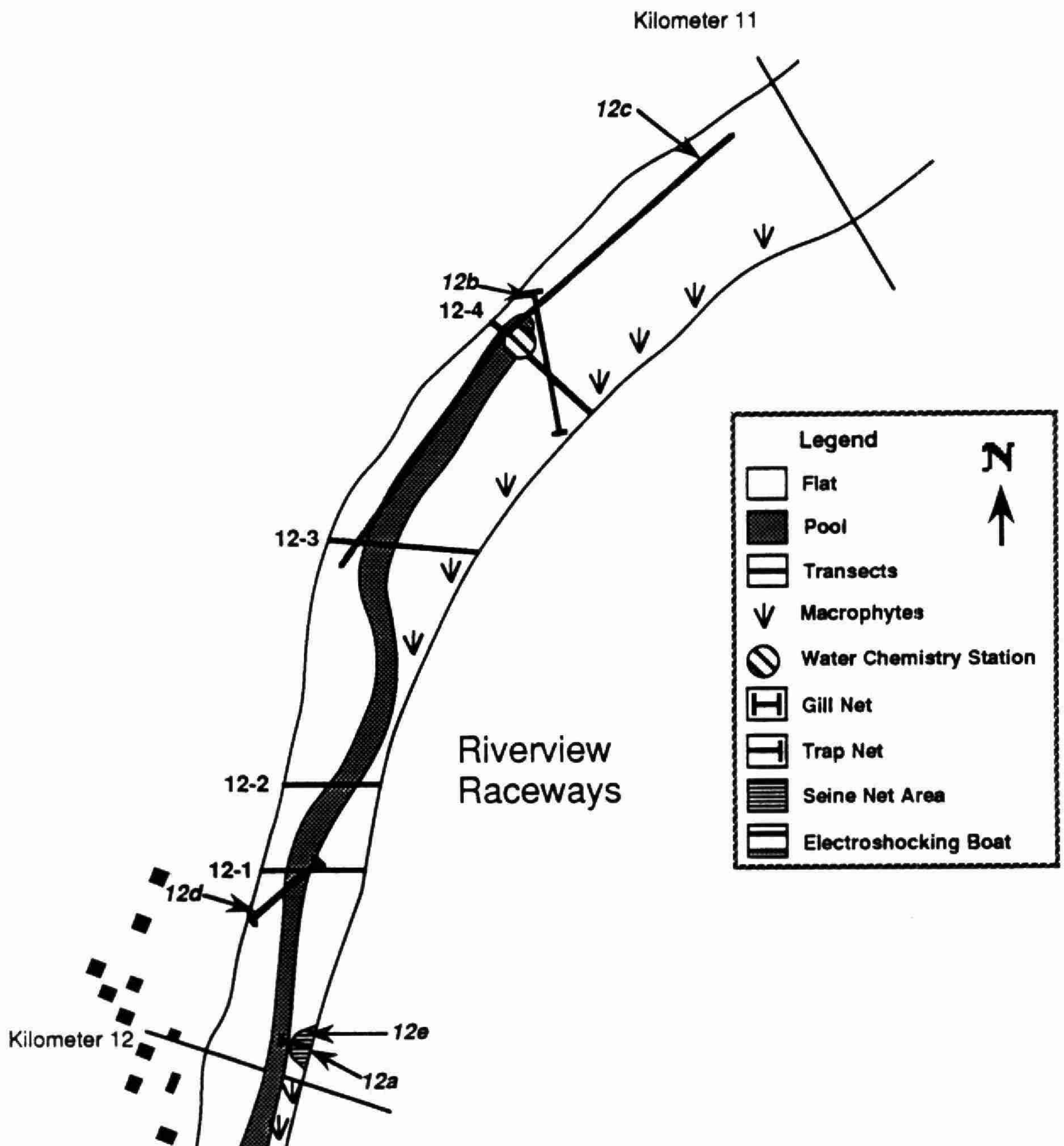
Appendix B-10. Instream Features and Collection Stations Kaministiquia River Kilometer 10, 1987.



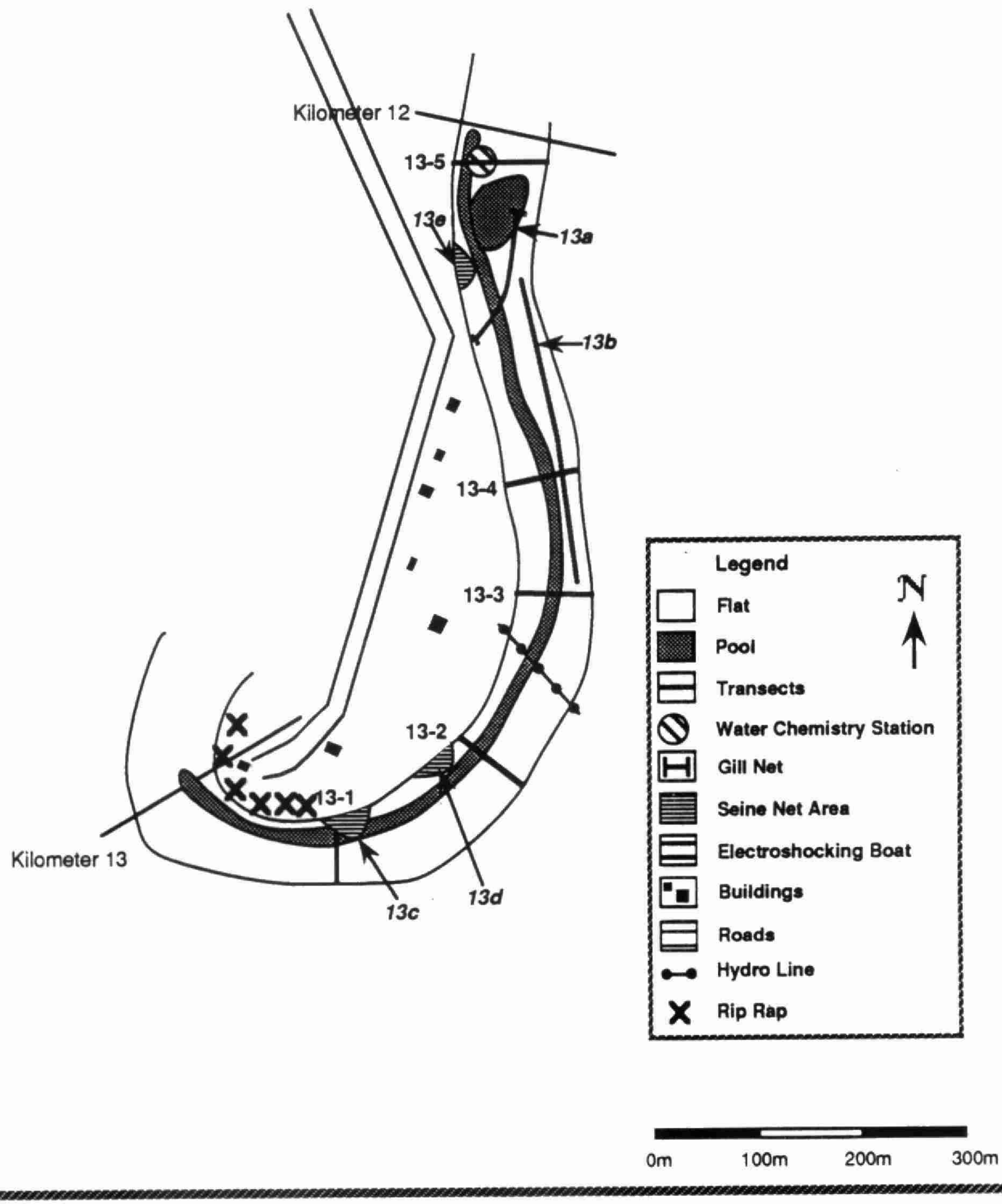
Appendix B-11. Instream Features and Collection Stations Kaministiquia River Kilometer 11, 1987.



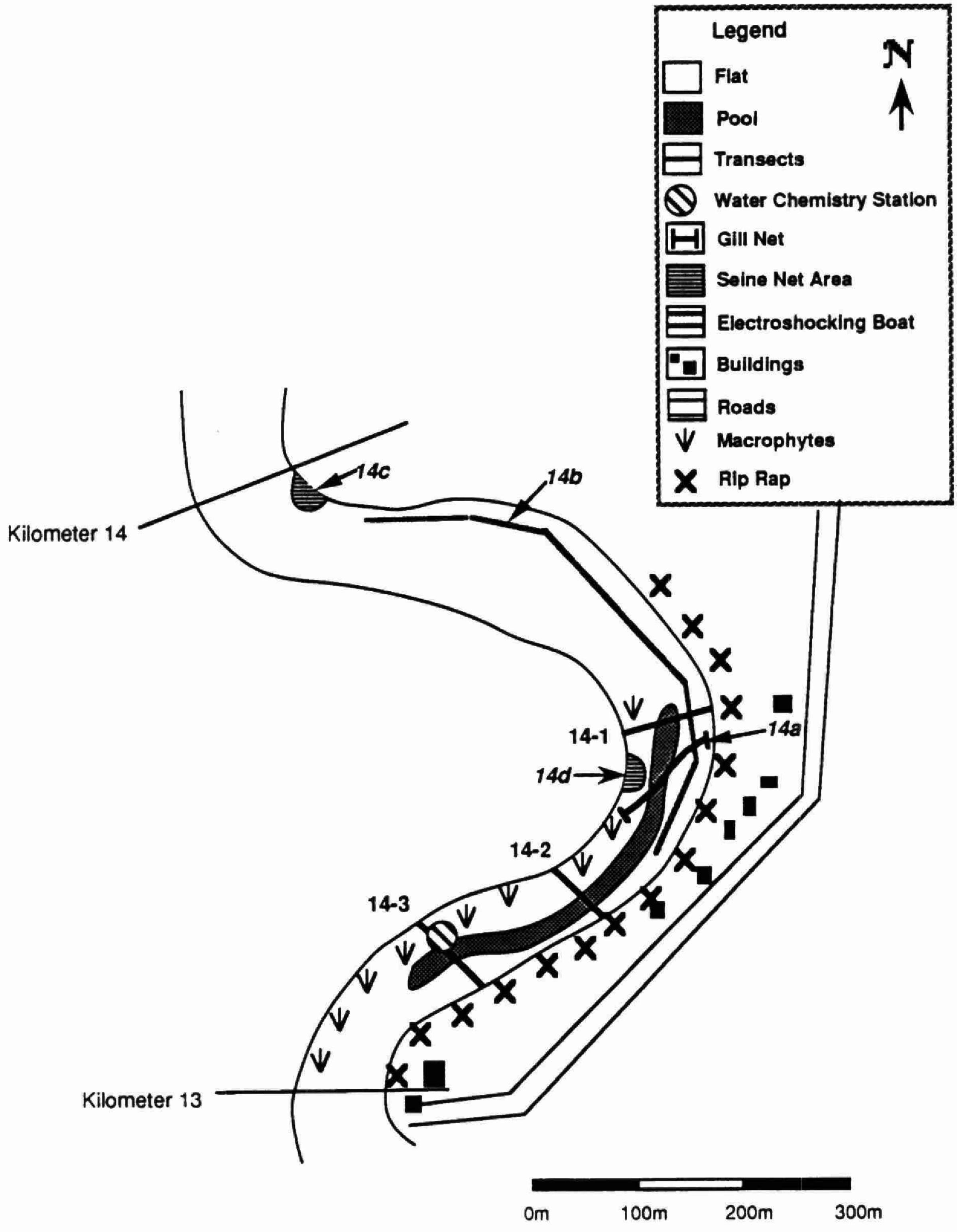
Appendix B-12. Instream Features and Collection Stations Kaministiquia River Kilometer 12, 1987.



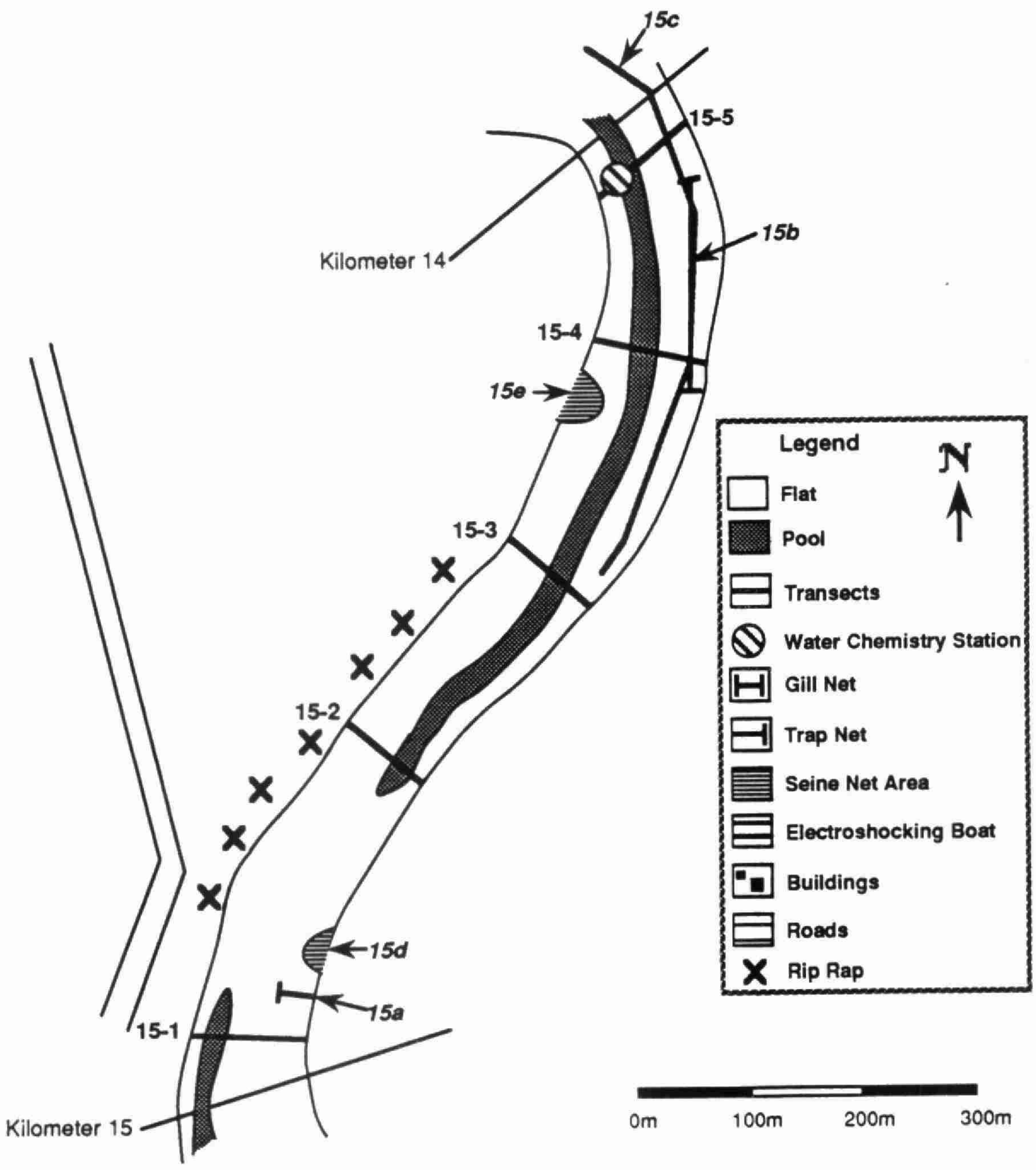
Appendix B-13. Instream Features and Collection Stations Kaministiquia River Kilometer 13, 1987.



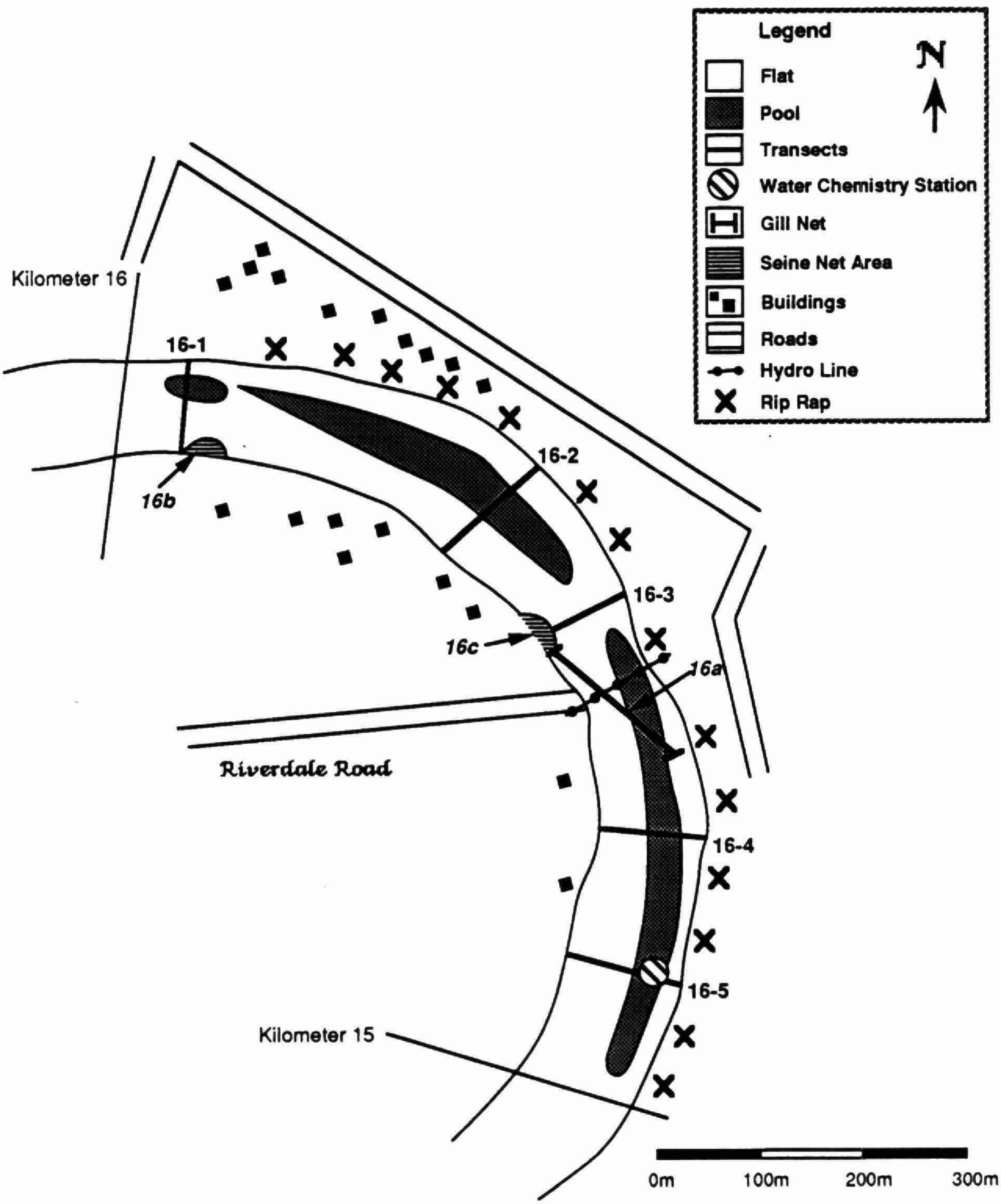
Appendix B-14. Instream Features and Collection Stations Kaministiquia River Kilometer 14, 1987.



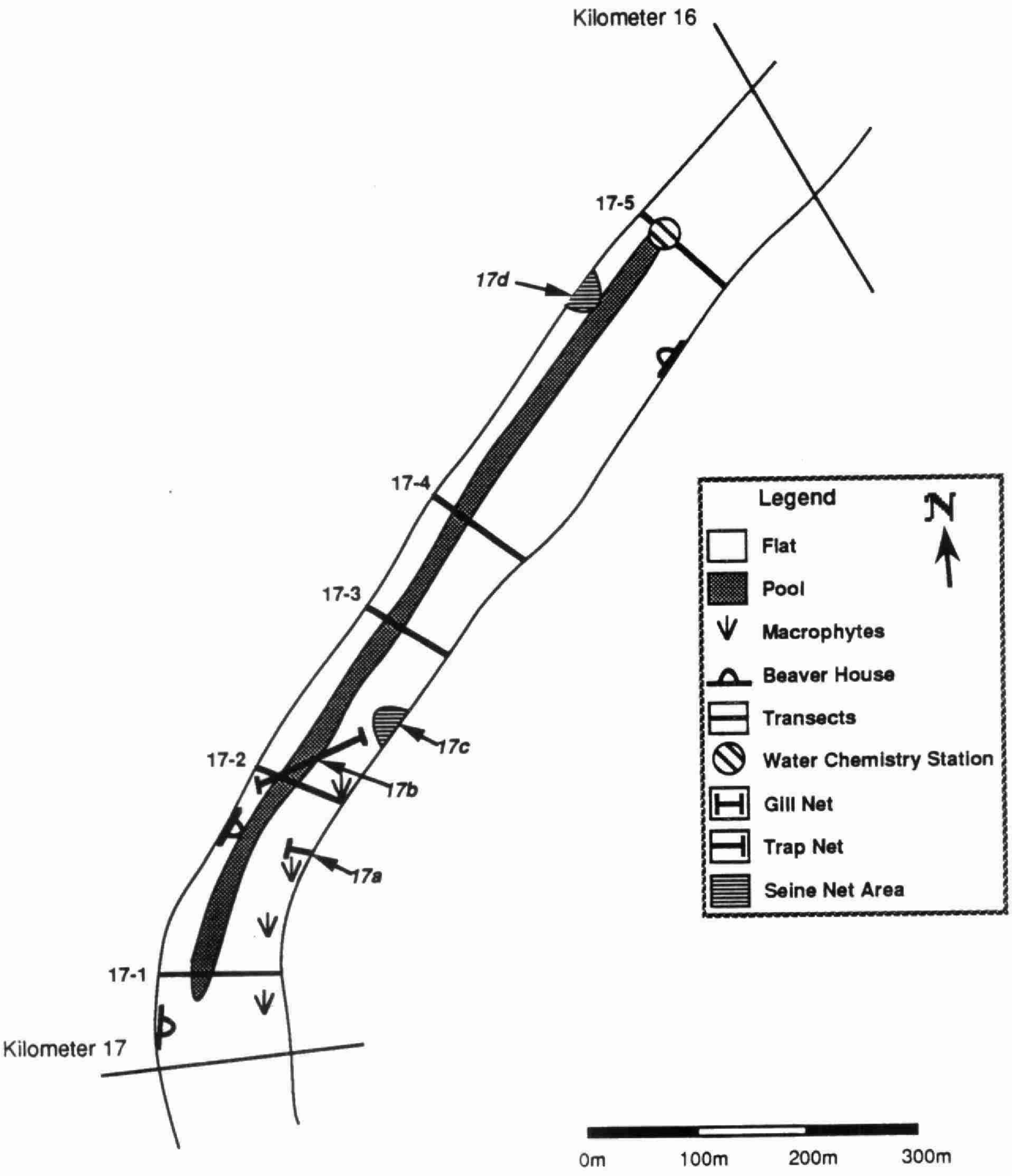
Appendix B-15. Instream Features and Collection Stations - Kaministiquia River Kilometer 15, 1987.



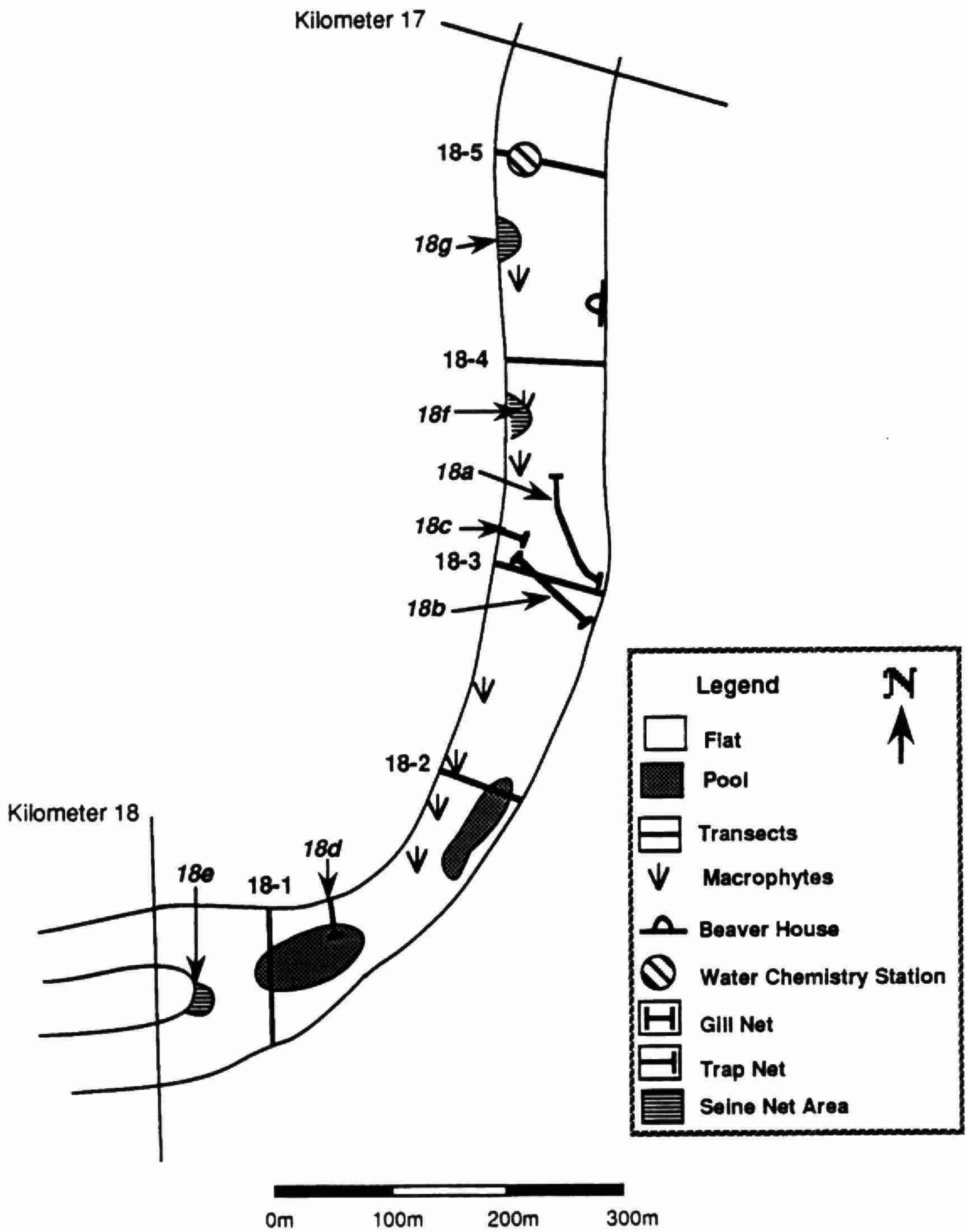
Appendix B-16. Instream Features and Collection Stations Kaministiquia River Kilometer 16, 1987.



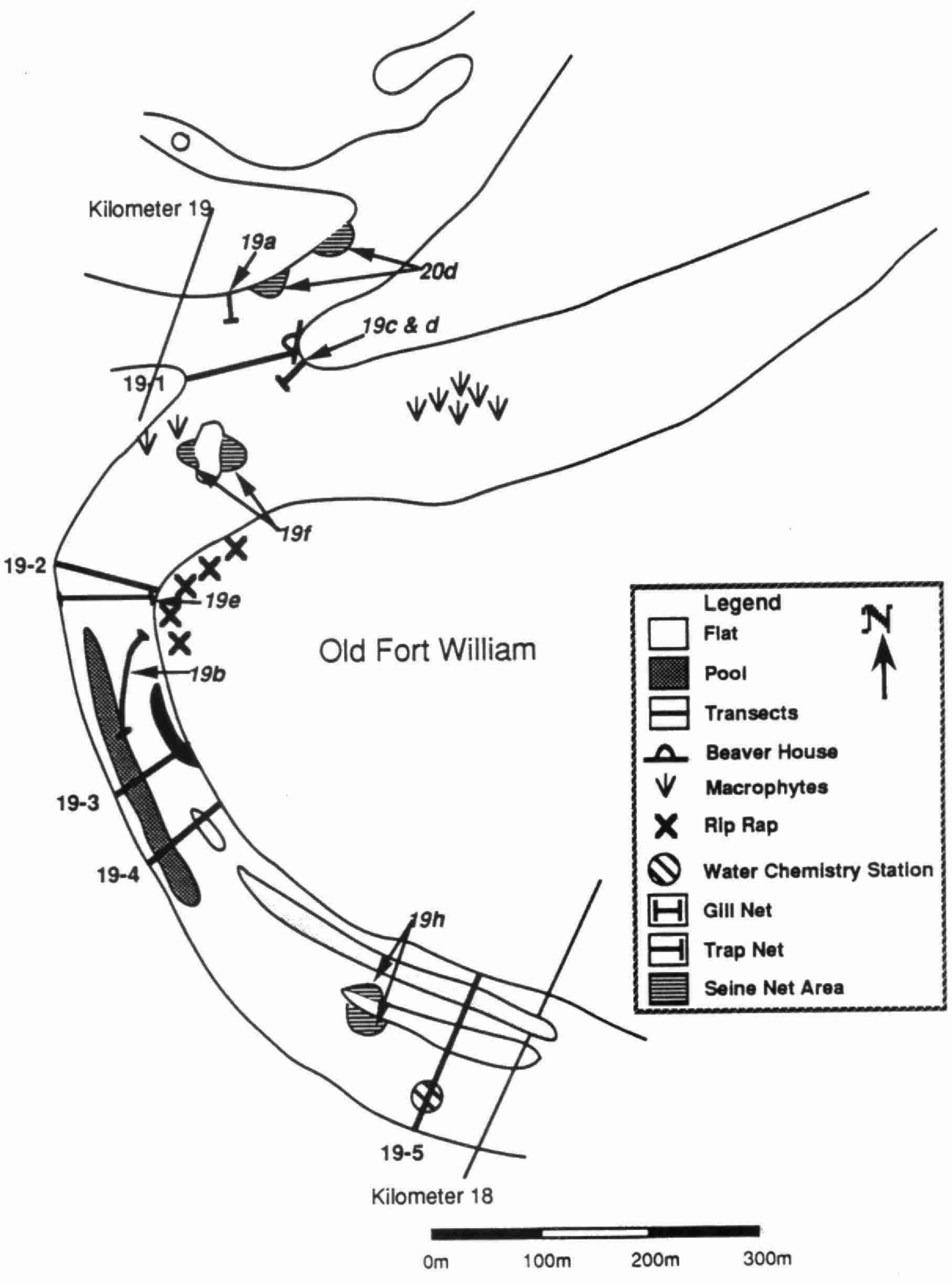
Appendix B-17. Instream Features and Collection Stations Kaministiquia River Kilometer 17, 1987.



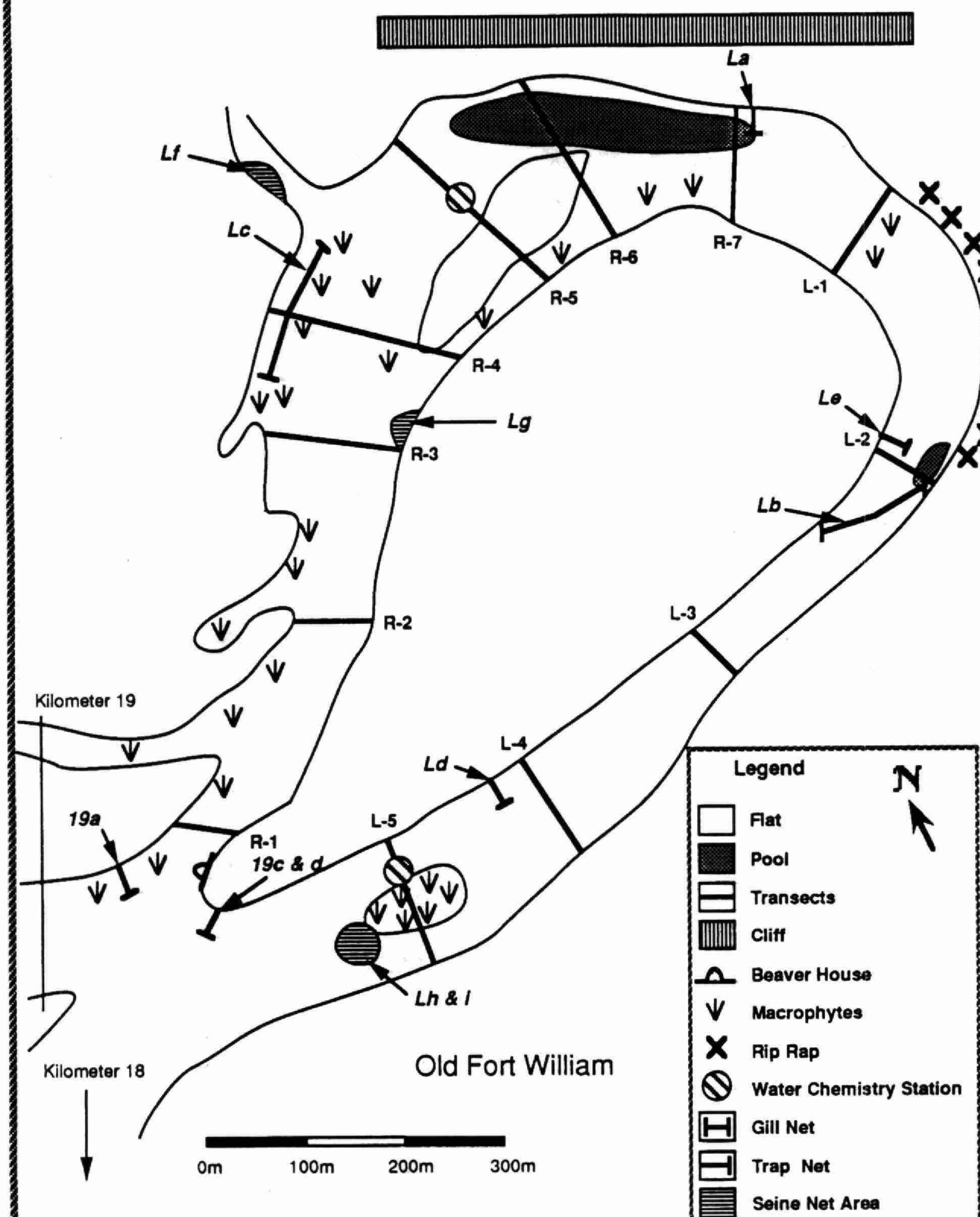
Appendix B-18. Instream Features and Collection Stations Kaministiquia River Kilometer 18, 1987.



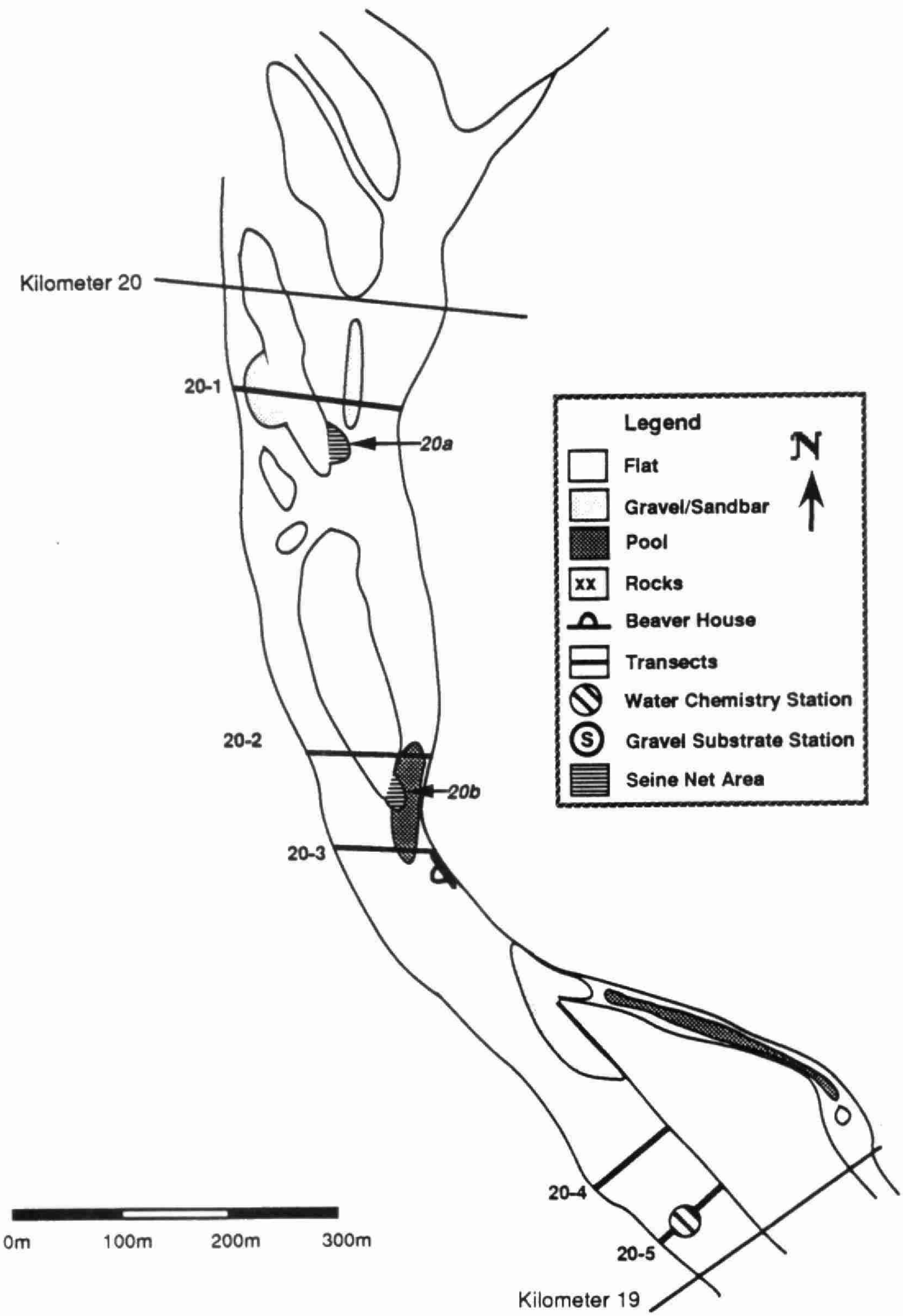
Appendix B-19 (i). Instream Features and Collection Stations Kaministiquia River Kilometer 19, 1987.



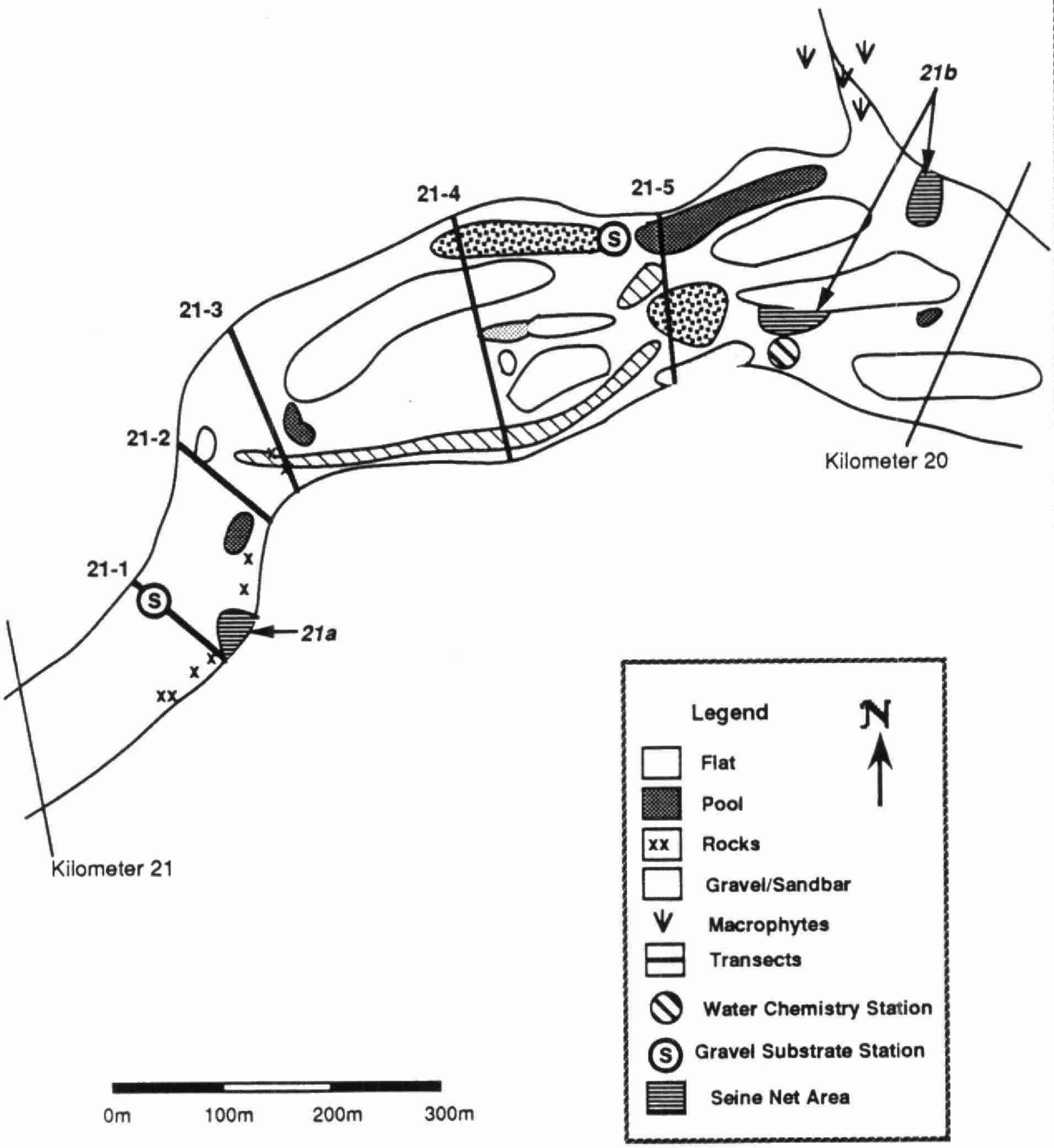
Appendix B- 19 (ii) Oxbow/Loop. Instream Features and Collection Stations Kaministiquia River Oxbow/Loop (Kilometer 19), 1987.



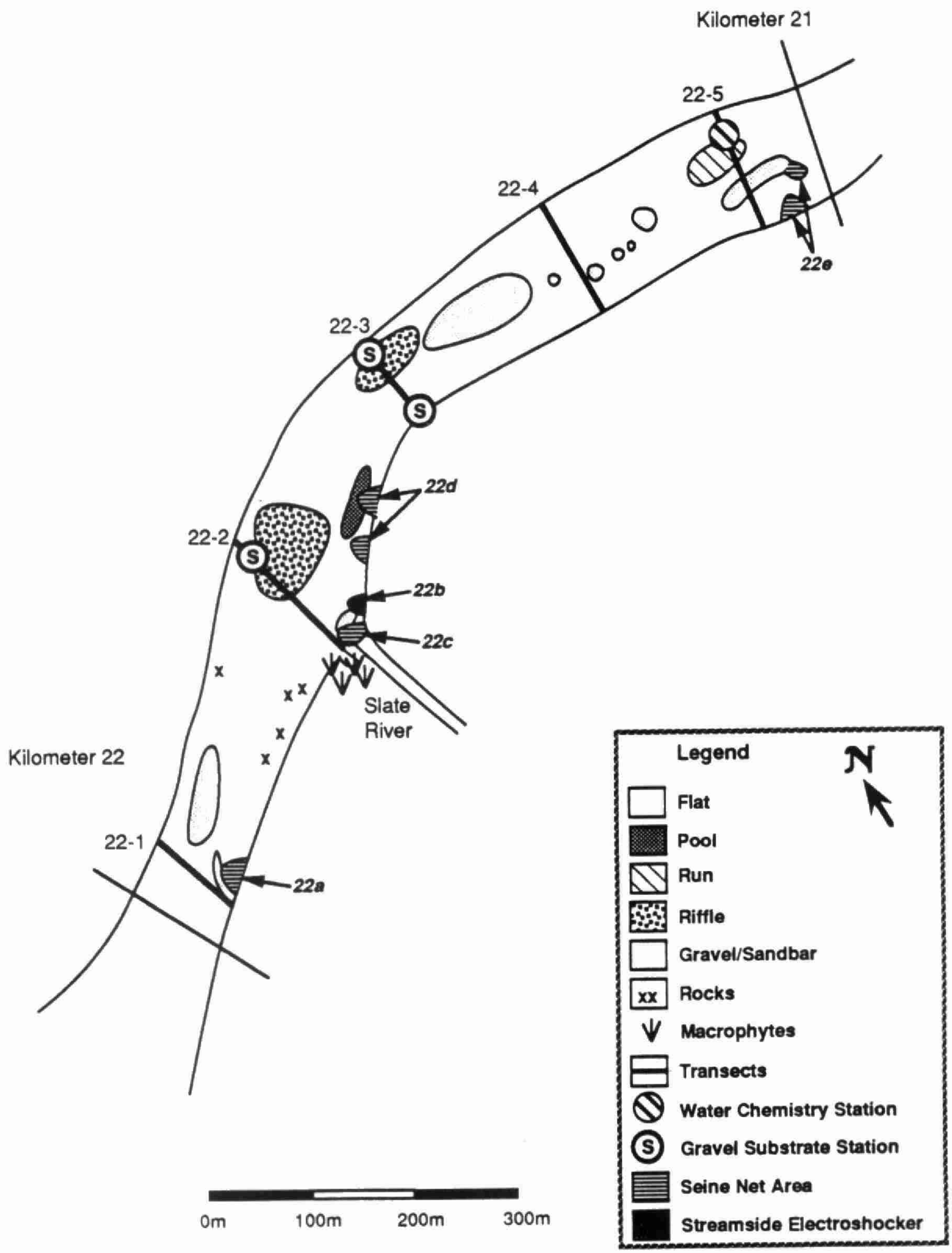
Appendix B-20. Instream Features and Collection Stations Kaministiquia River Kilometer 20, 1987.



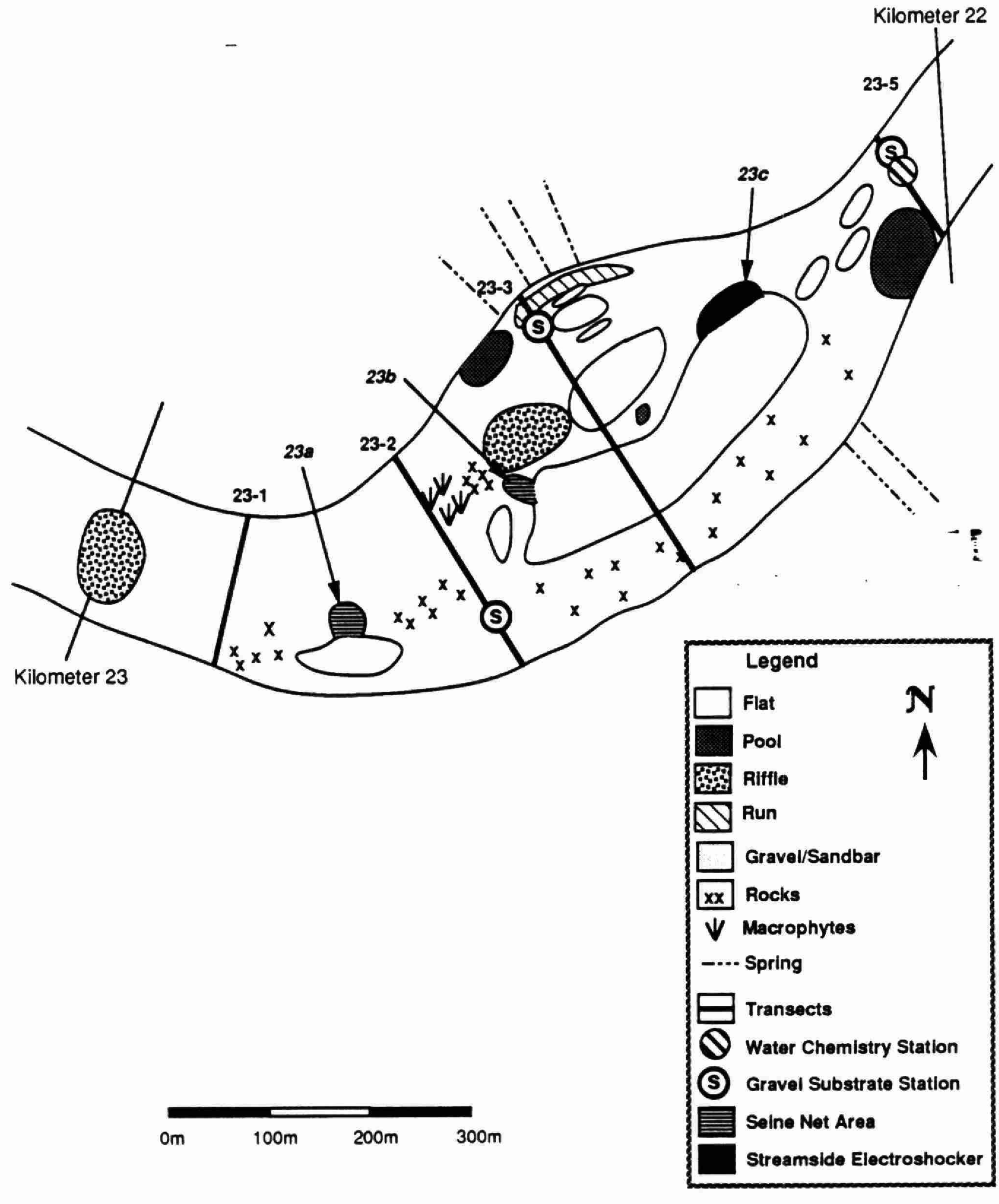
Appendix B-21. Instream Features and Collection Stations Kaministiquia River Kilometer 21, 1987.



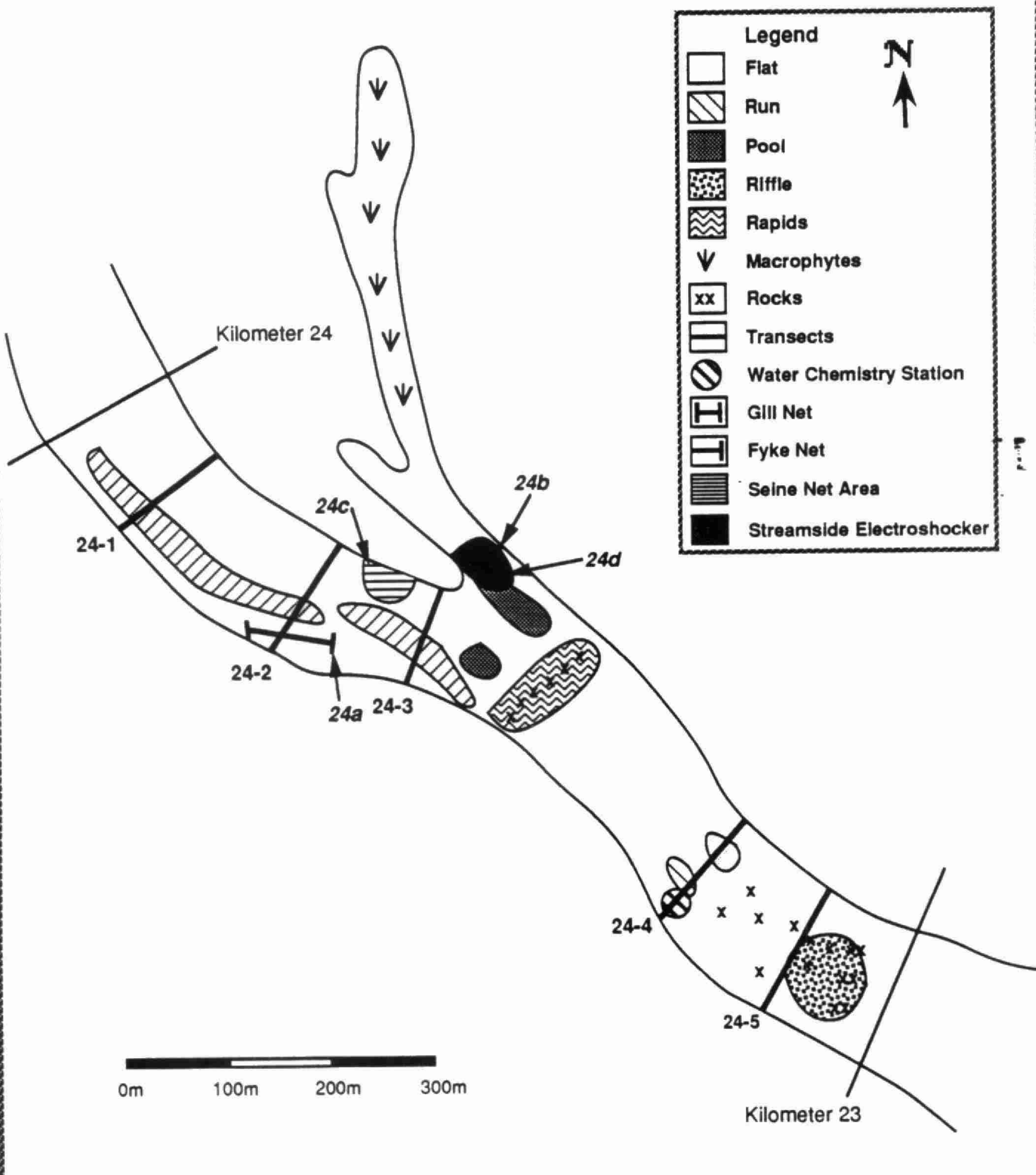
Appendix B-22. Instream Features and Collection Stations Kaministiquia River Kilometer 22, 1987.



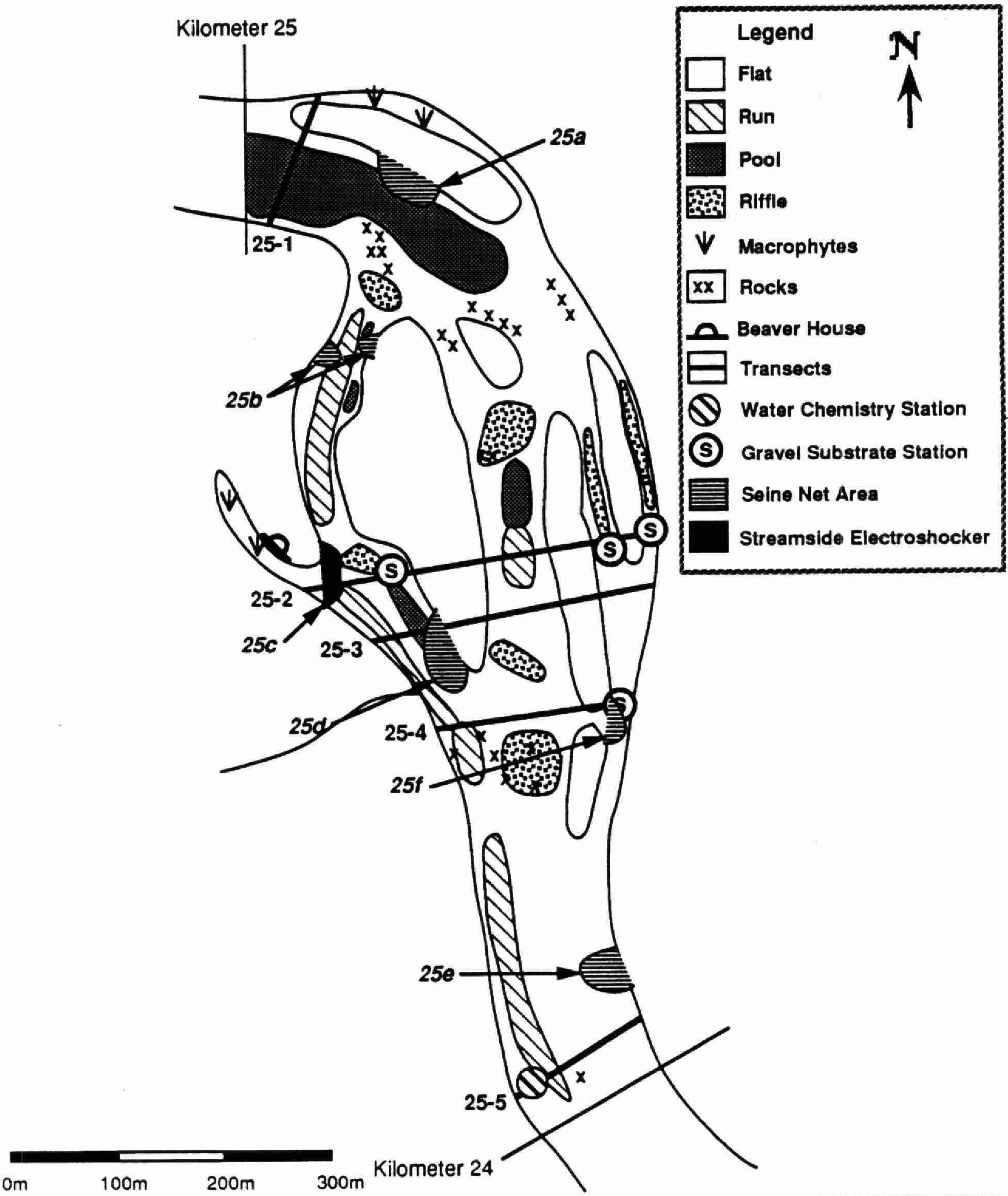
Appendix B-23. Instream Features and Collection Stations Kaministiquia River Kilometer 23, 1987.



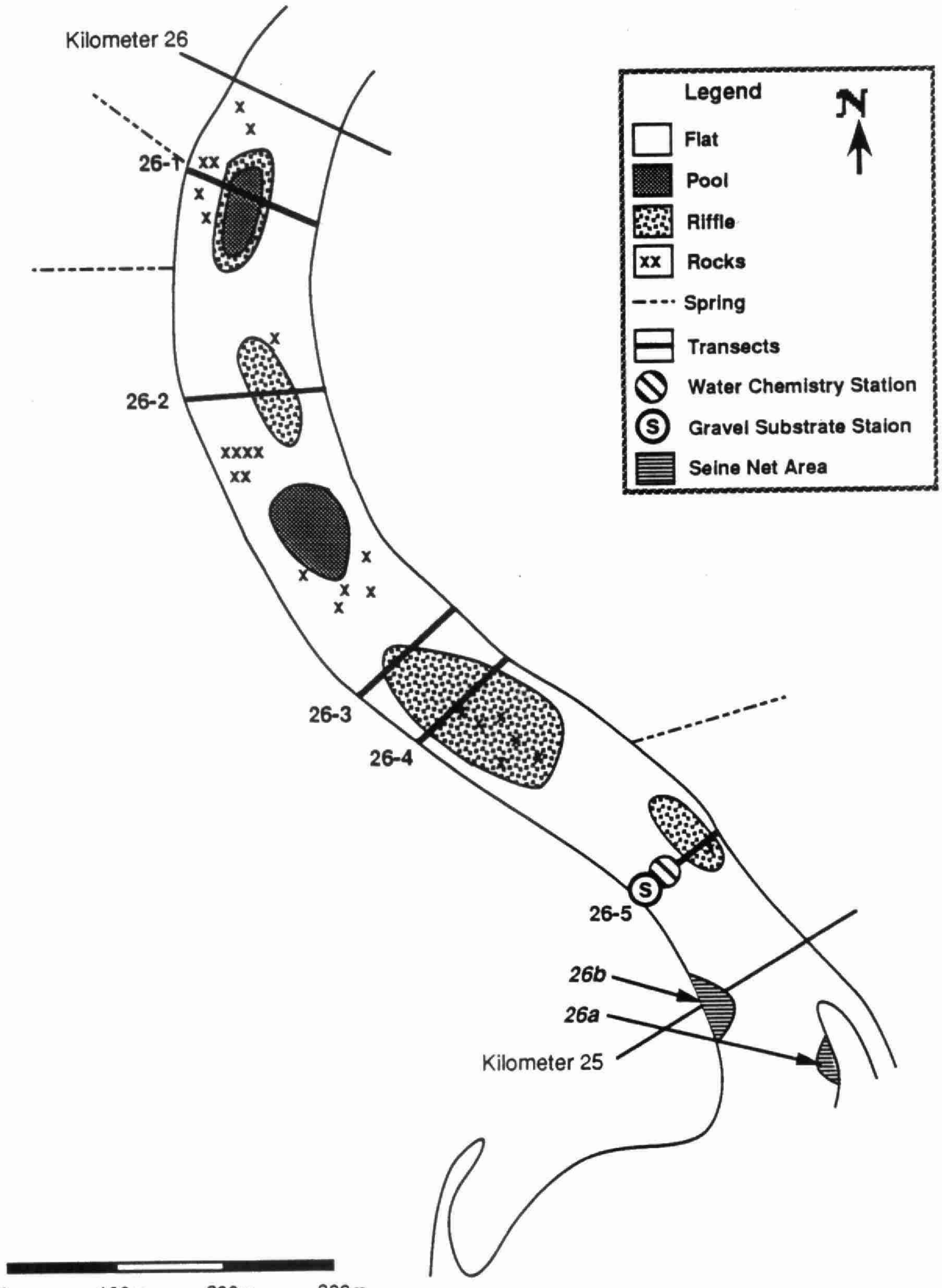
Appendix B-24. Instream Features and Collection Stations Kaministiquia River Kilometer 24, 1987.



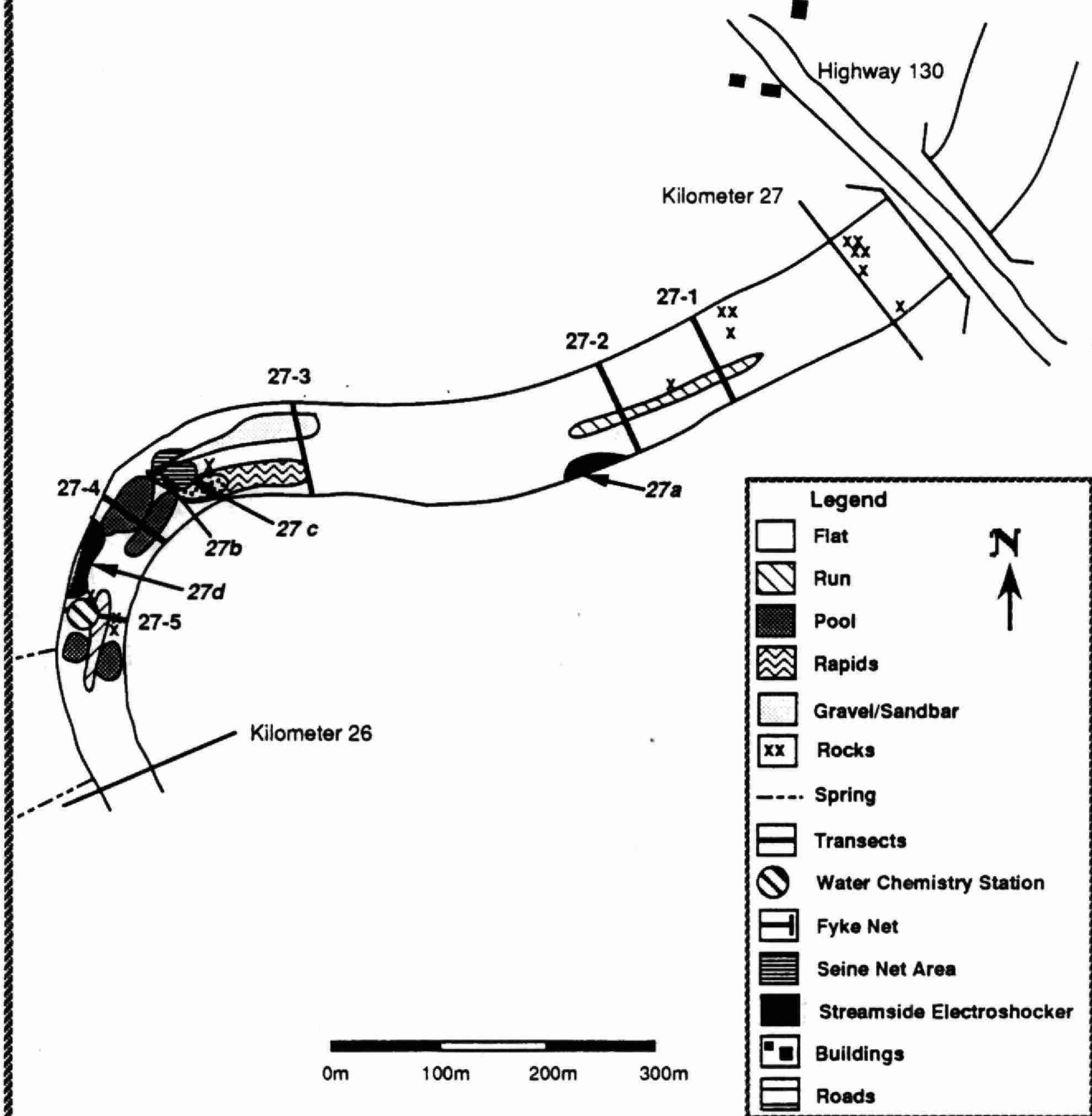
Appendix B-25. Instream Features and Collection Stations Kaministiquia River Kilometer 25, 1987.



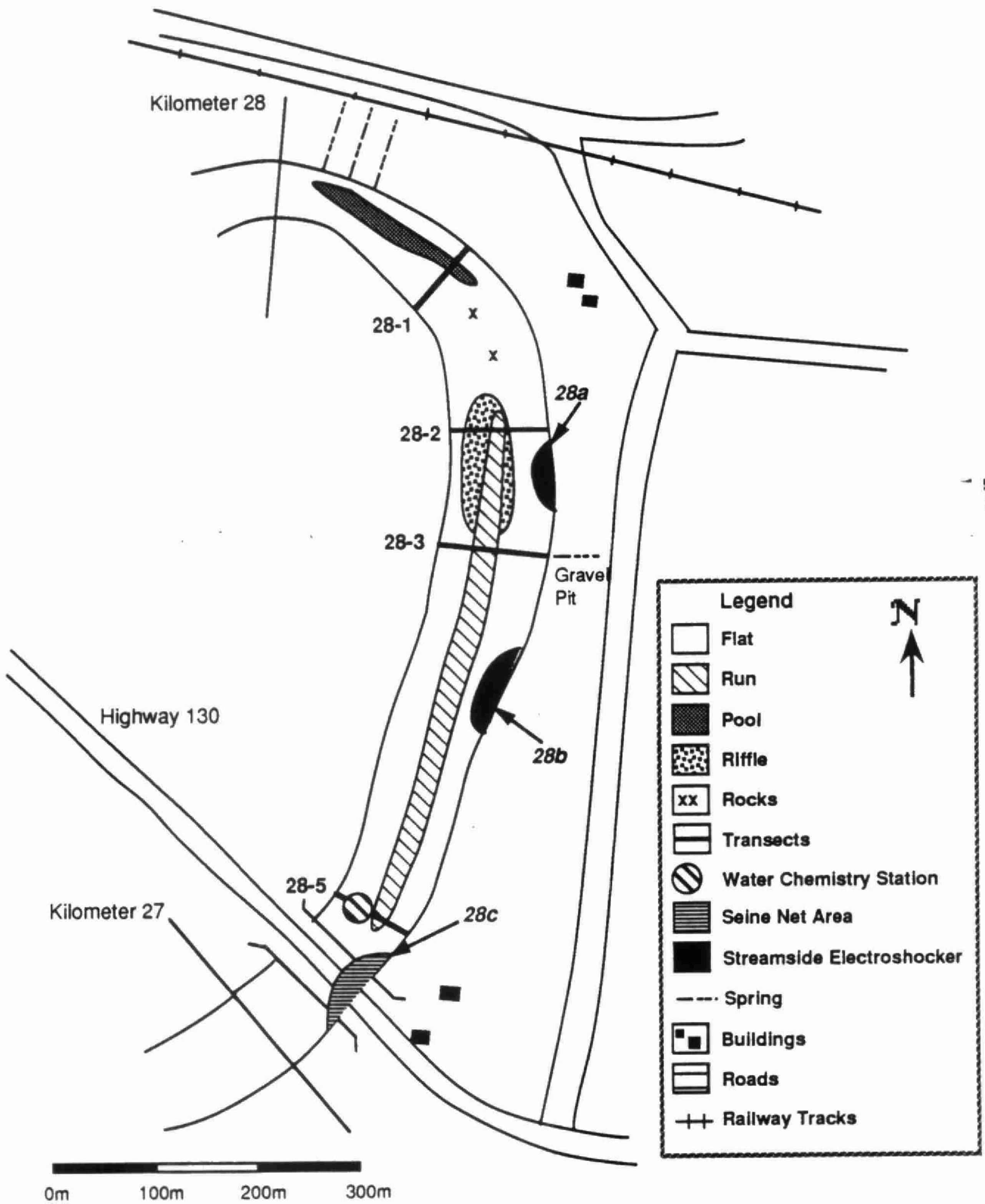
Appendix B-26. Instream Features and Collection Stations Kaministiquia River Kilometer 26, 1987.



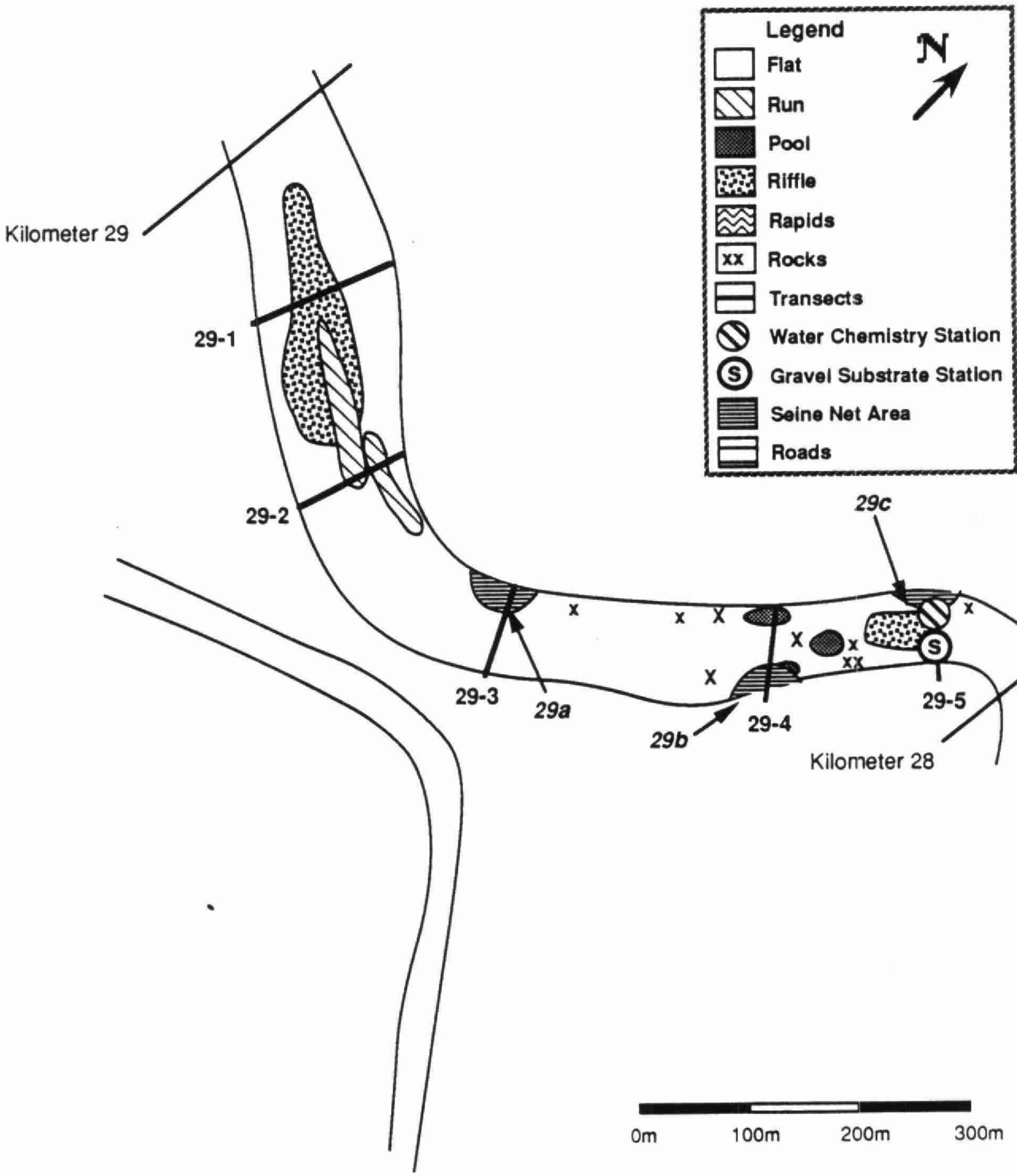
Appendix B-27. Instream Features and Collection Stations - Kaministiquia River Kilometer 27, 1987.



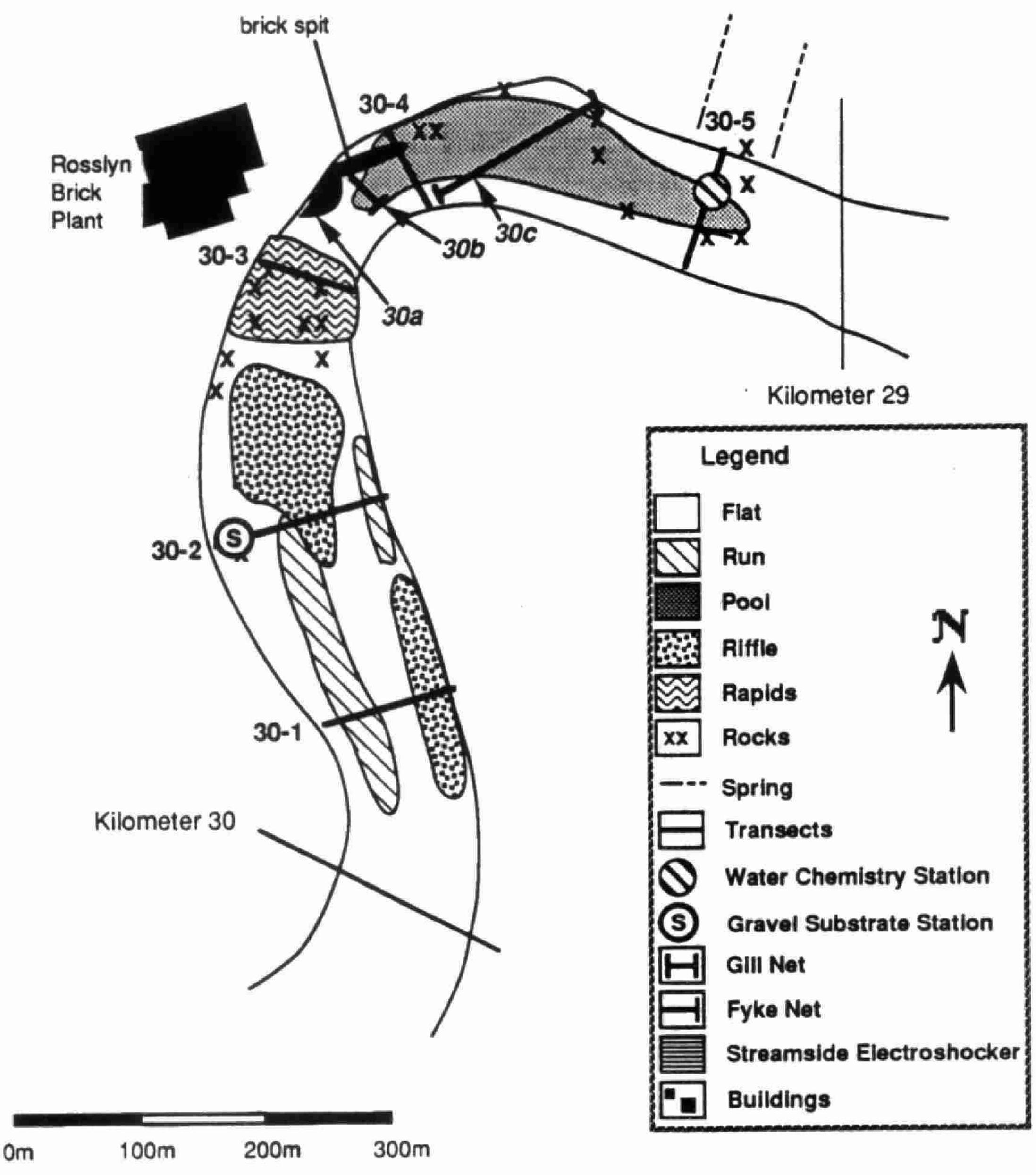
Appendix B-28. Instream Features and Collection Stations Kaministiquia River Kilometer 28, 1987.



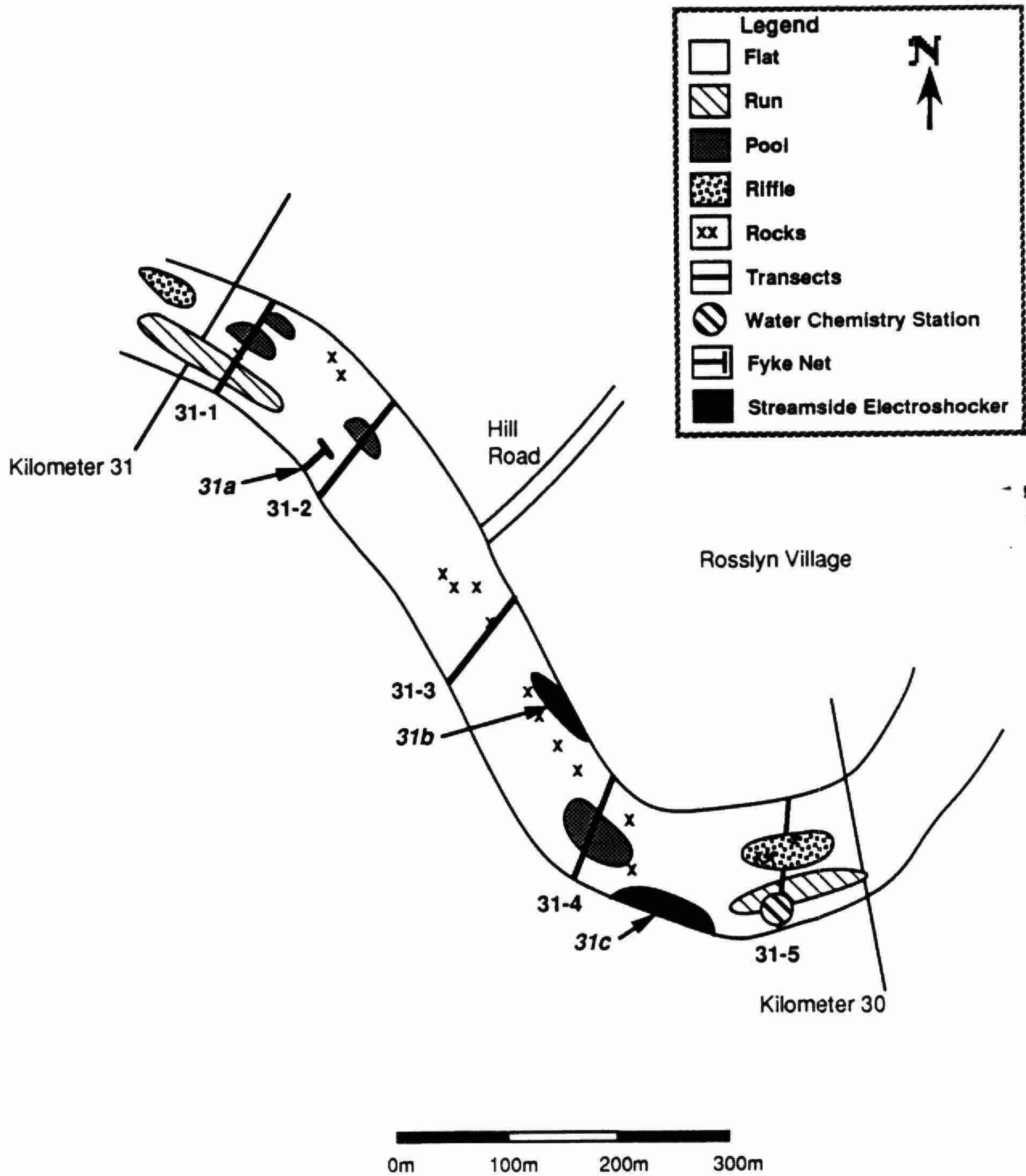
Appendix B-29. Instream Features and Collection Stations Kaministiquia River Kilometer 29, 1987.



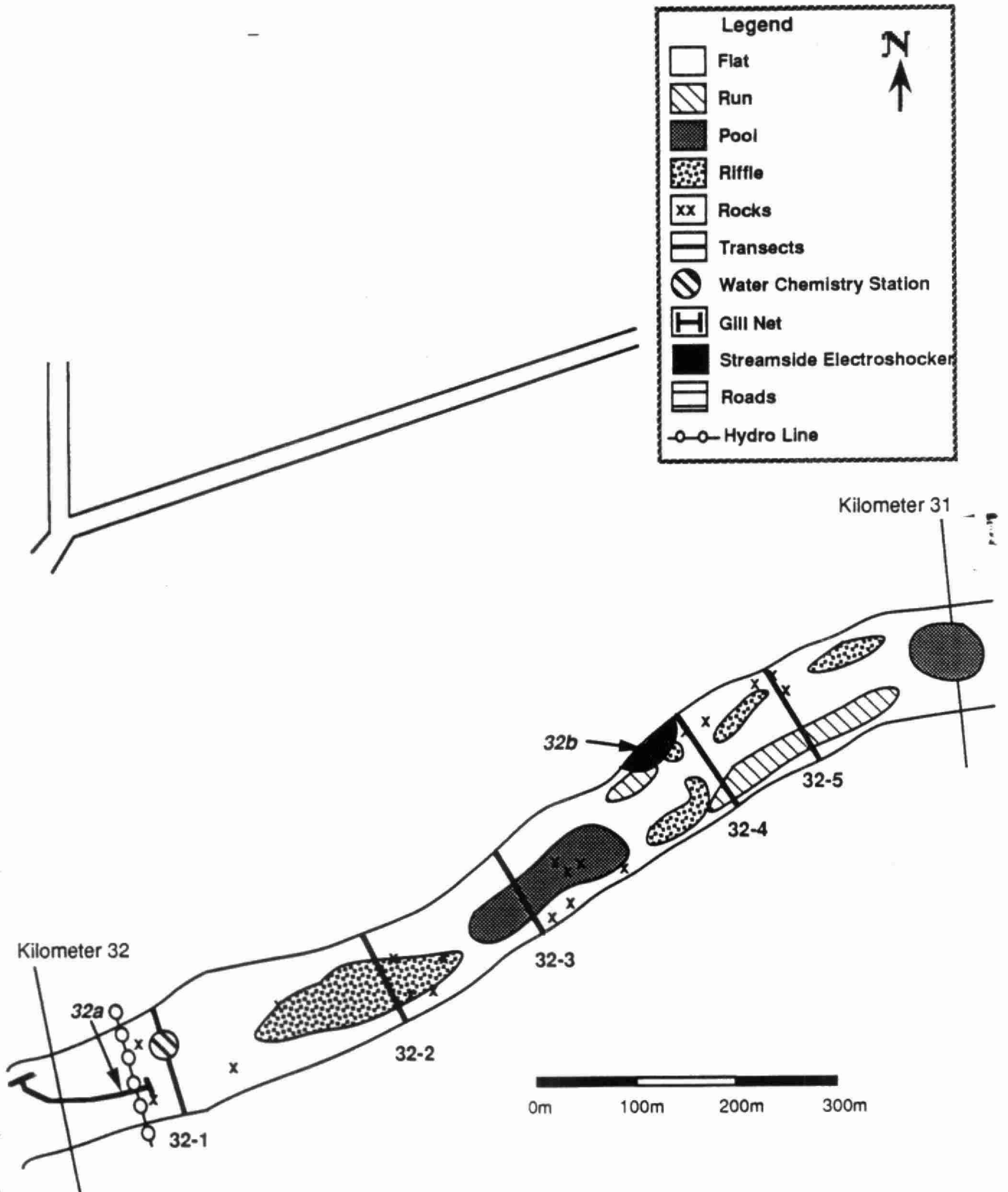
Appendix B-30. Instream Features and Collection Stations Kaministiquia River Kilometer 30, 1987.



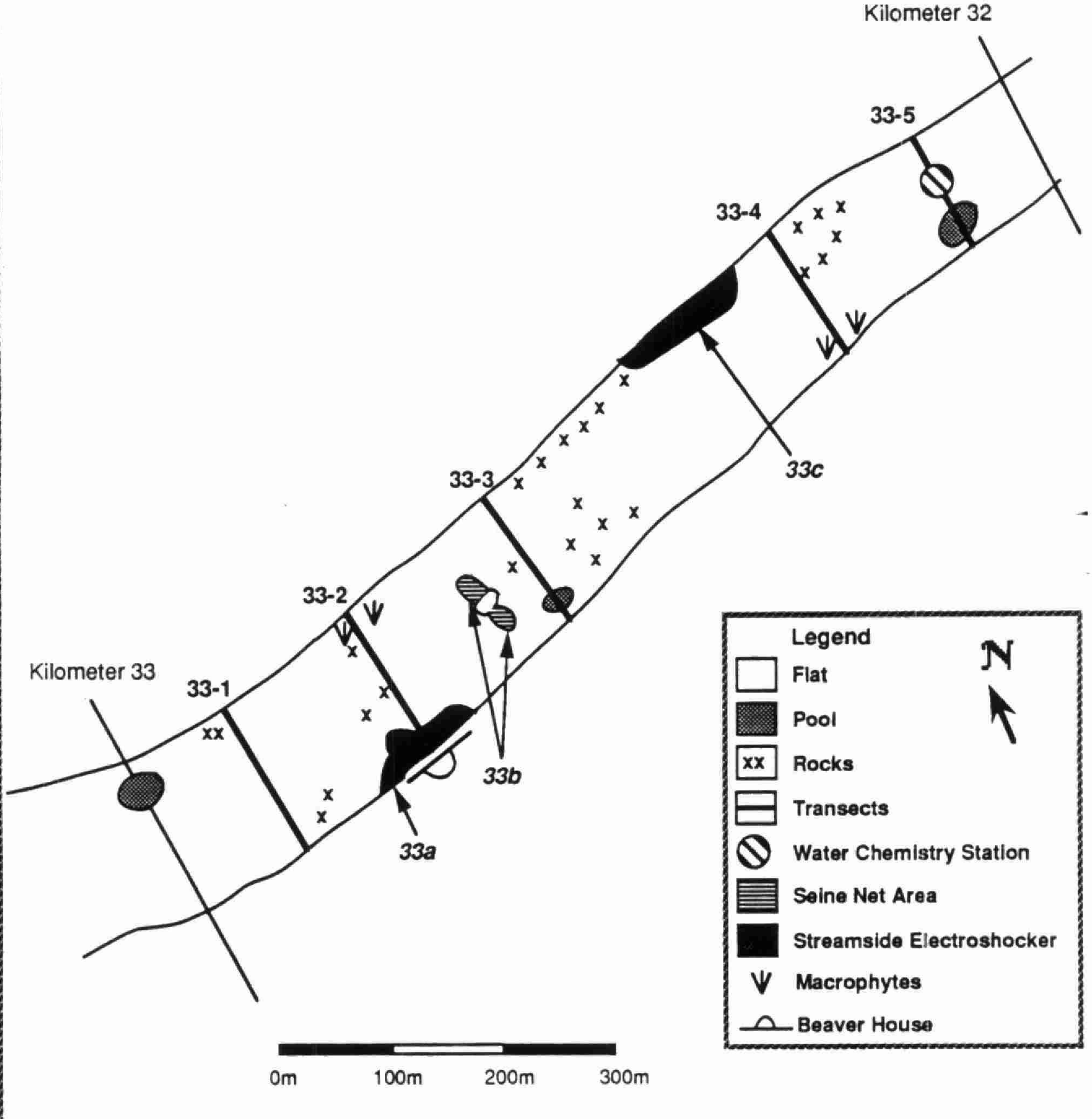
Appendix B-31. Instream Features and Collection Stations Kaministiquia River Kilometer 31, 1987.



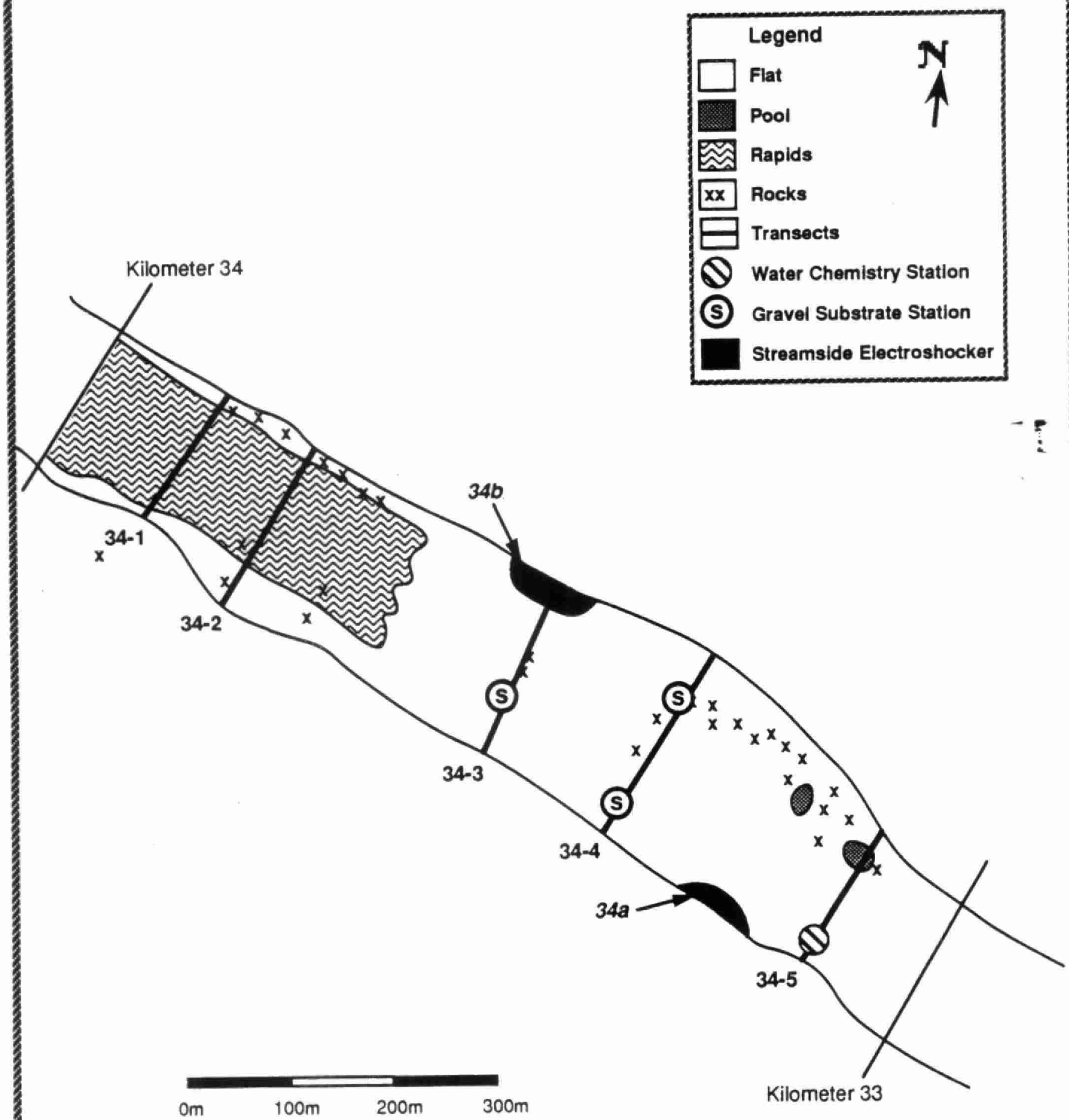
Appendix B-32. Instream Features and Collection Stations Kaministiquia River Kilometer 32, 1987.



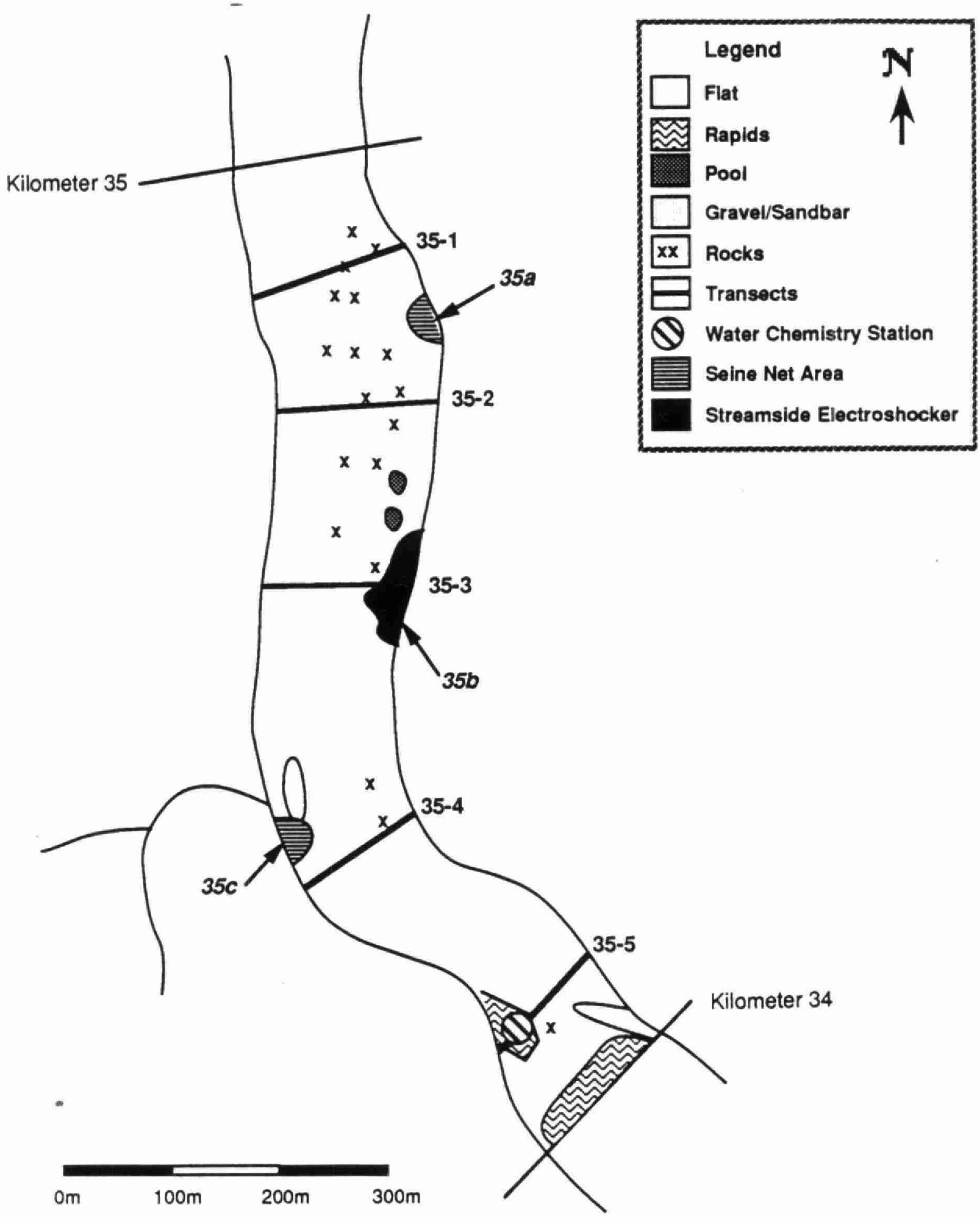
Appendix B-33. Instream Features and Collection Stations Kaministiquia River Kilometer 33, 1987.



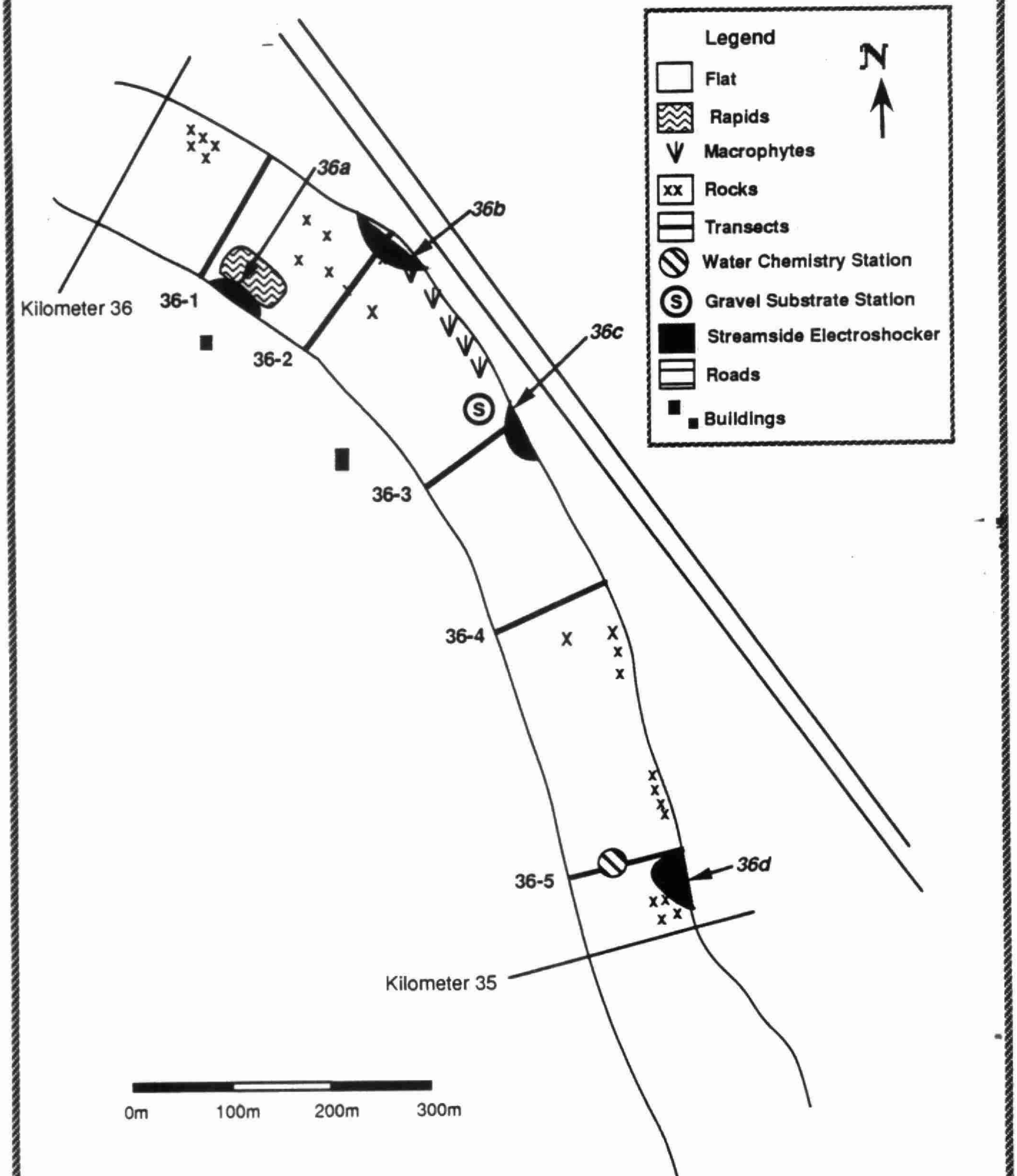
Appendix B-34. Instream Features and Collection Stations Kaministiquia River Kilometer 34, 1987.



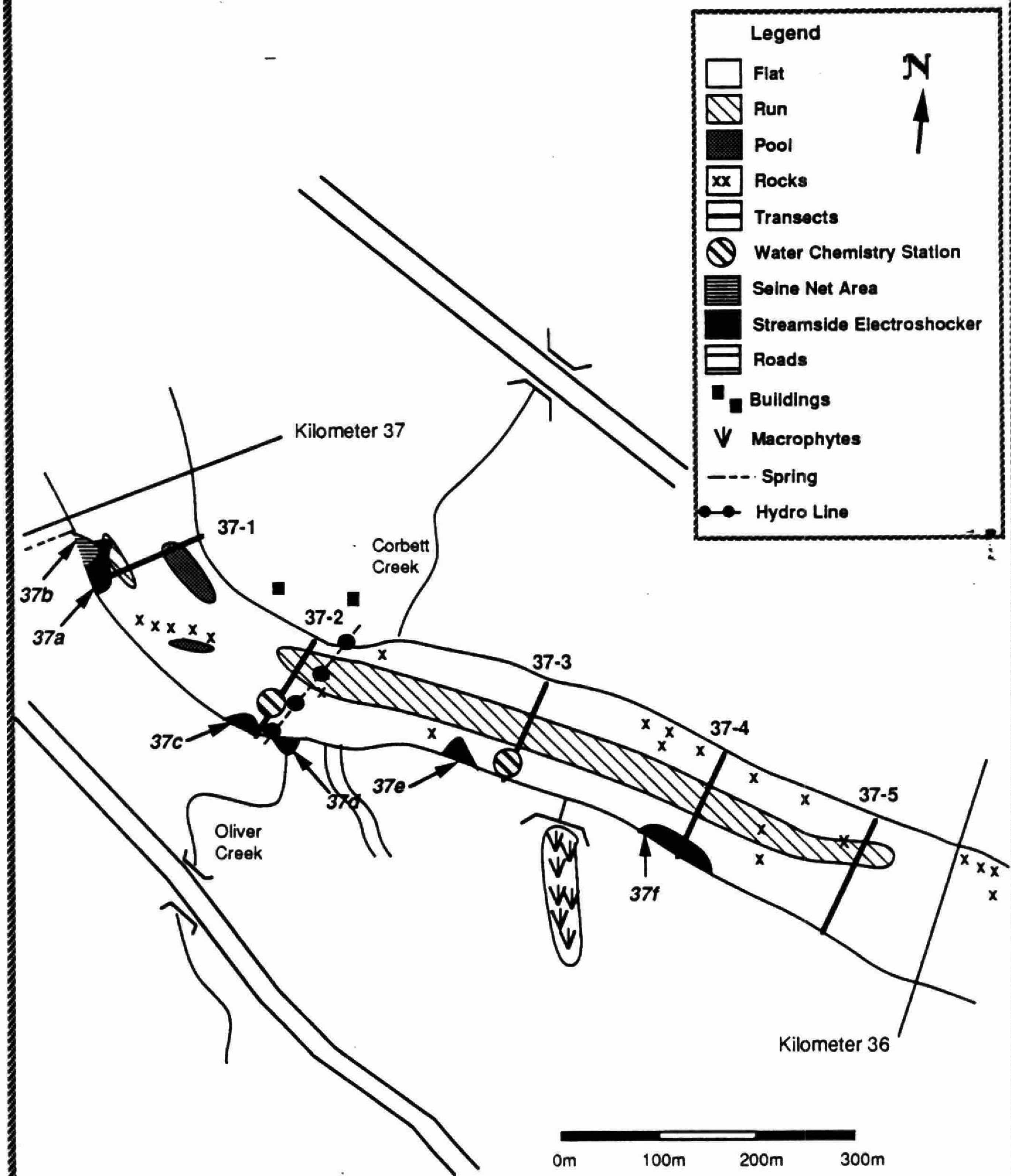
Appendix B-35. Instream Features and Collection Stations Kaministiquia River Kilometer 35, 1987.



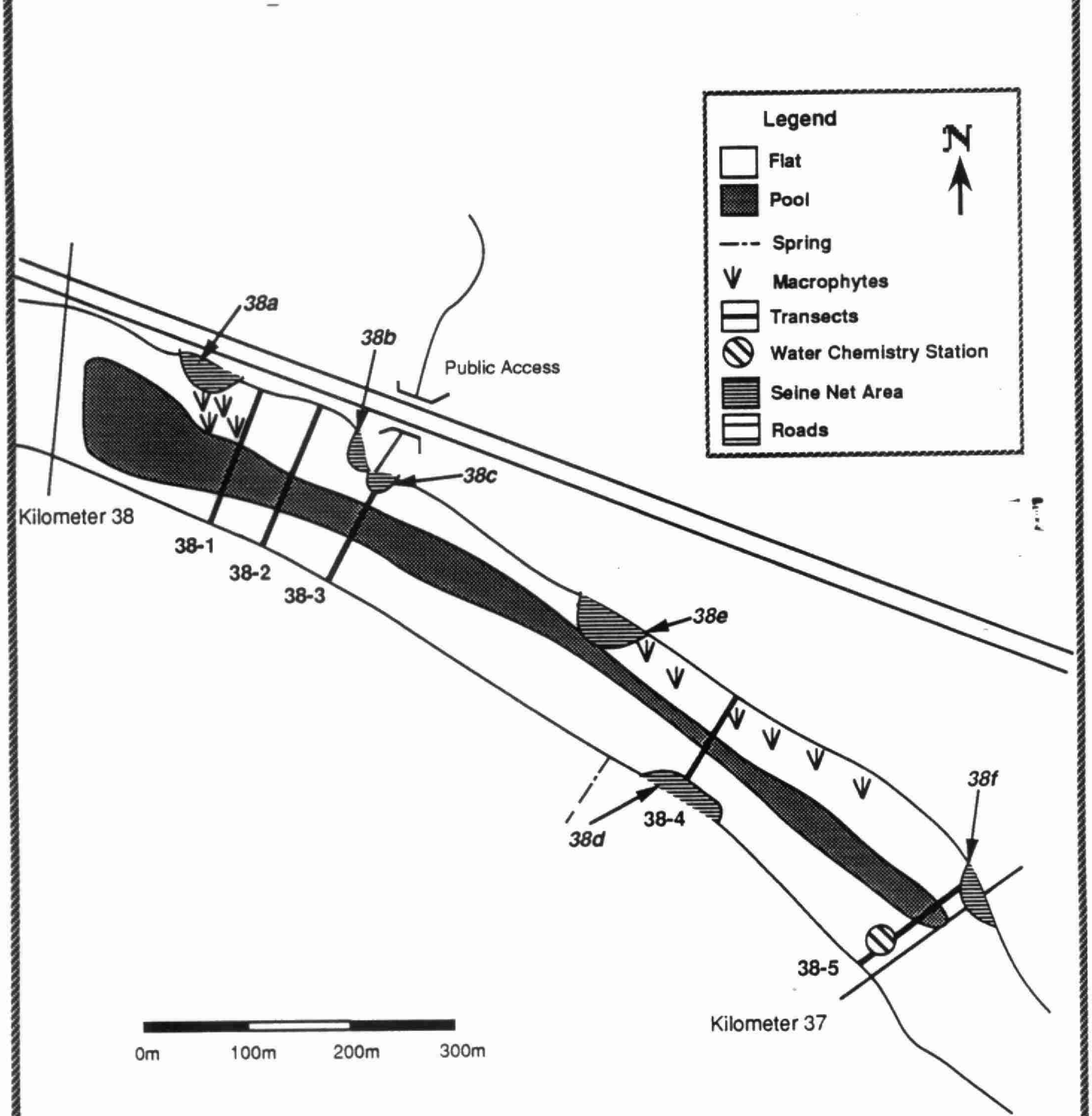
Appendix B-36. Instream Features and Collection Stations Kaministiquia River Kilometer 36, 1987.



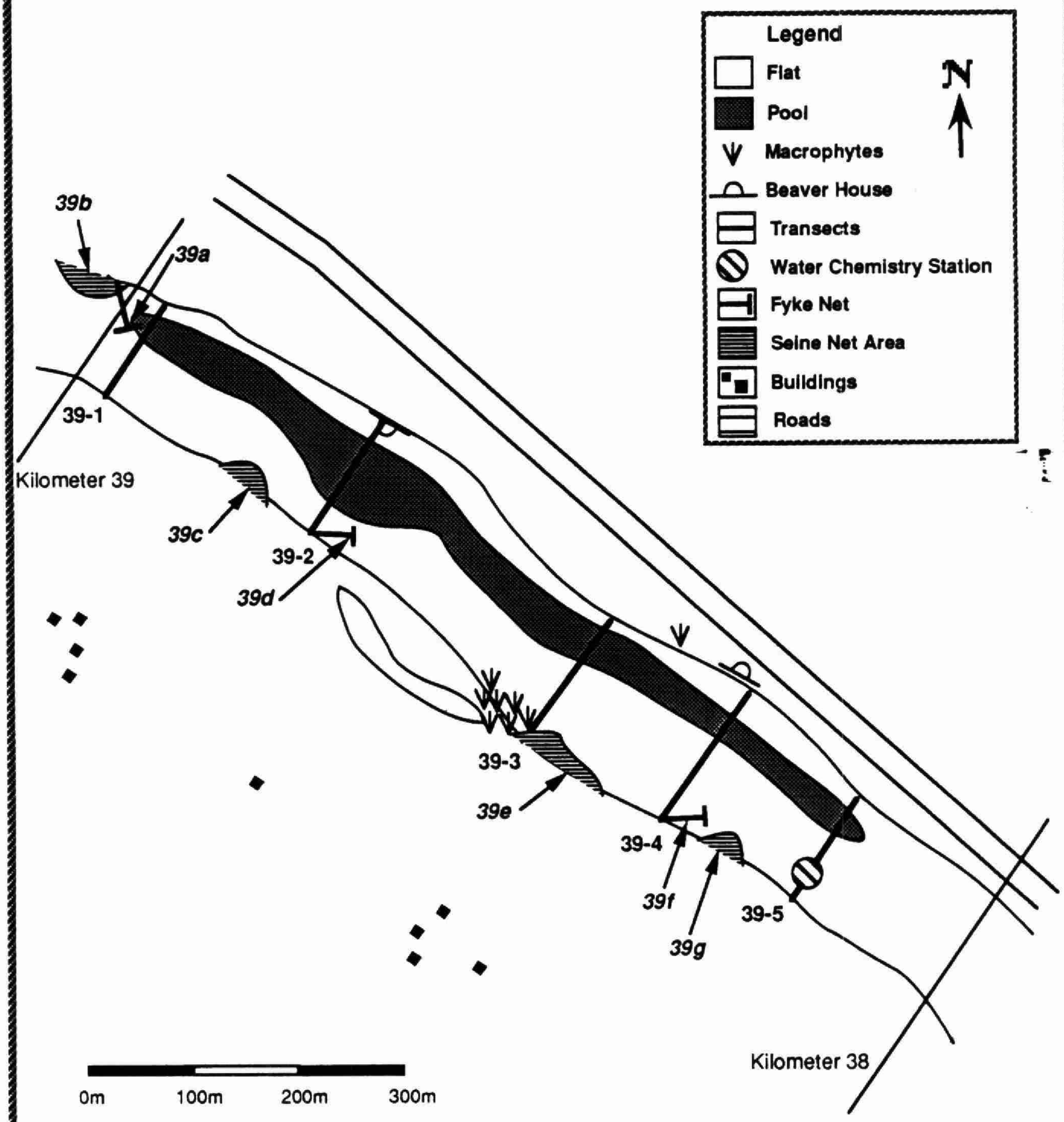
Appendix B-37. Instream Features and Collection Stations Kaministiquia River Kilometer 37, 1987.



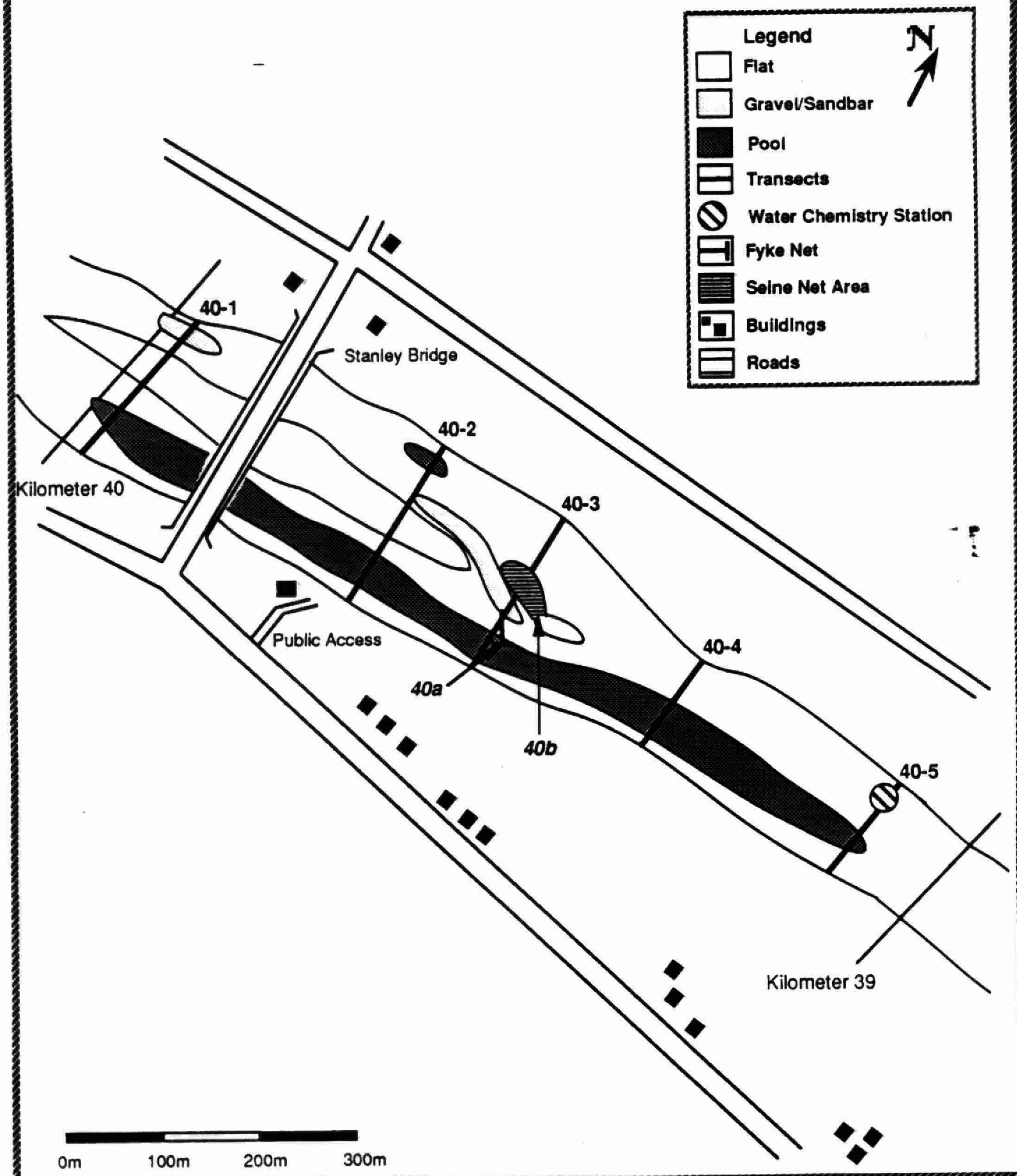
Appendix B-38. Instream Features and Collection Stations Kaministiquia River Kilometer 38, 1987.



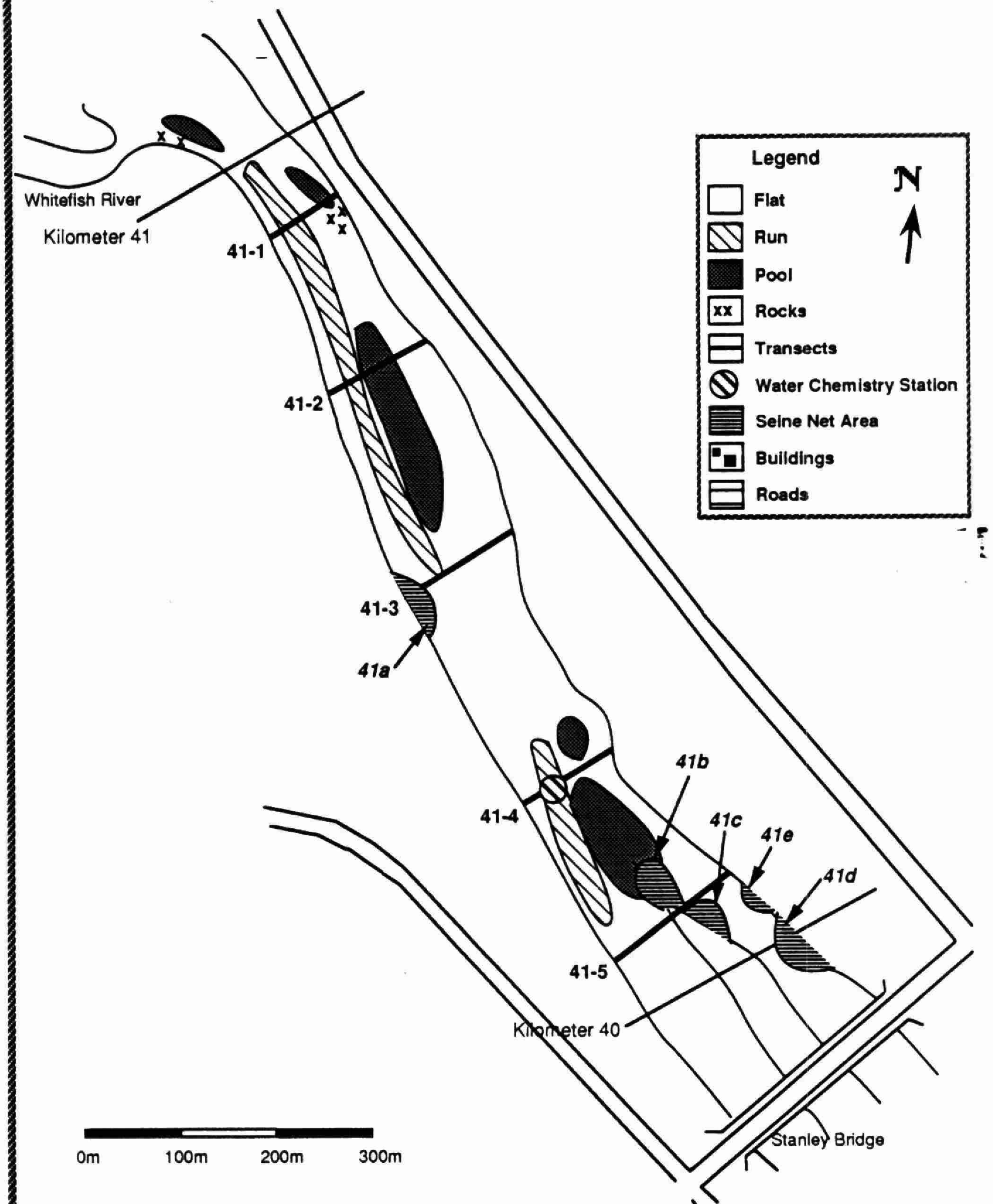
Appendix B-39. Instream Features and Collection Stations Kaministiquia River Kilometer 39, 1987.



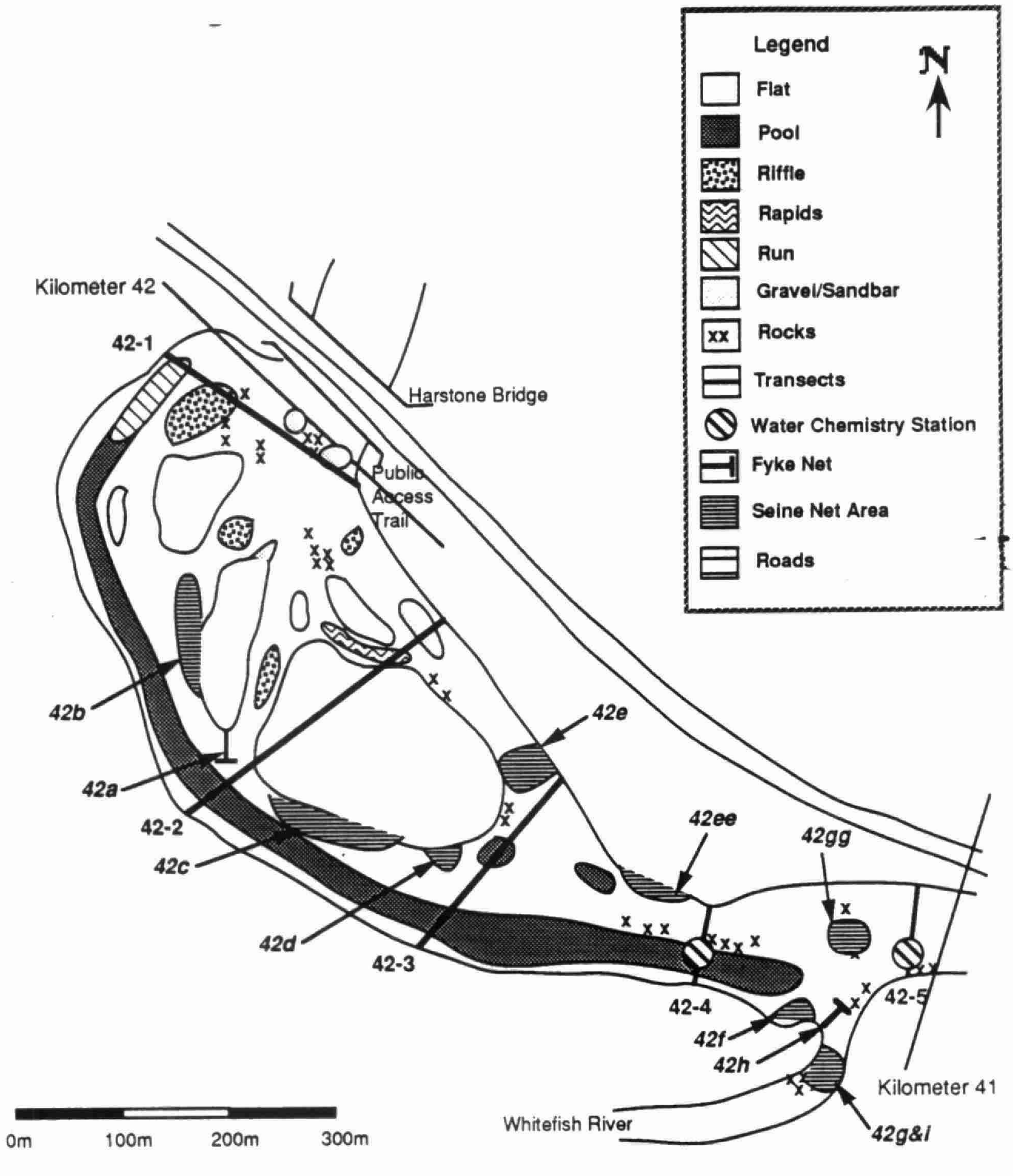
Appendix B-40. Instream Features and Collection Stations Kaministiquia River Kilometer 40, 1987.



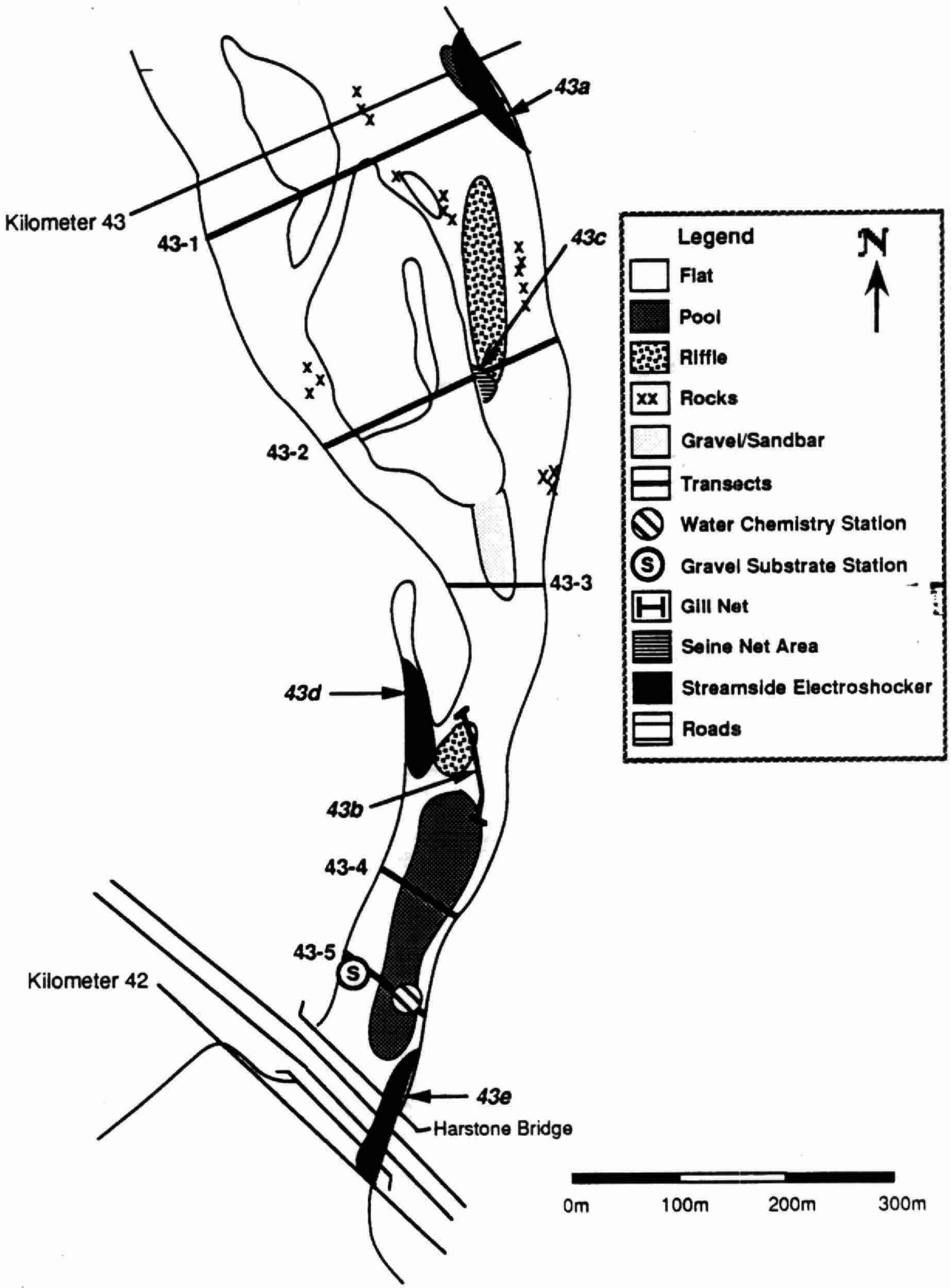
Appendix B-41. Instream Features and Collection Stations Kaministiquia River Kilometer 41, 1987.



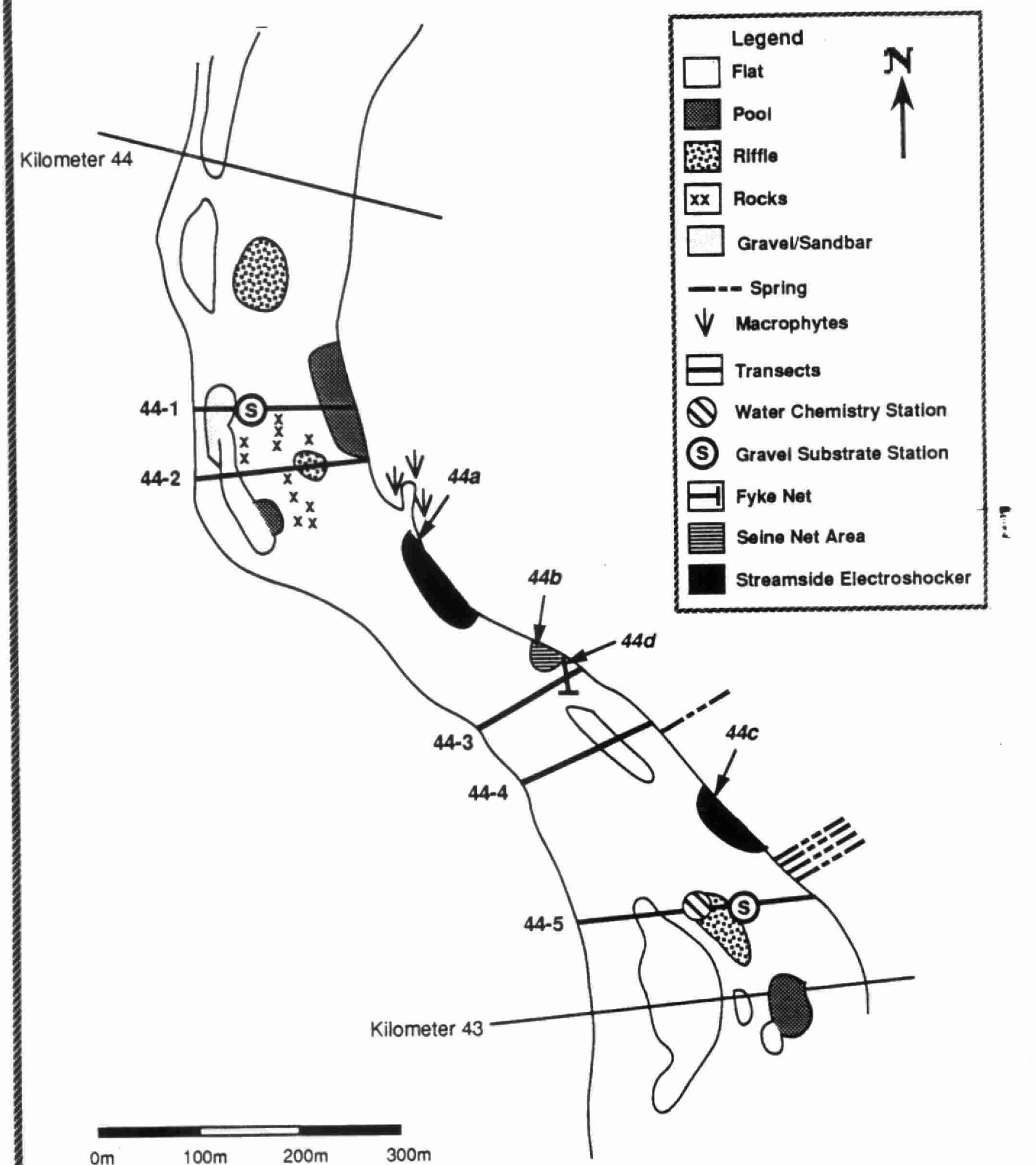
Appendix B-42. Instream Features and Collection Stations Kaministiquia River Kilometer 42, 1987.



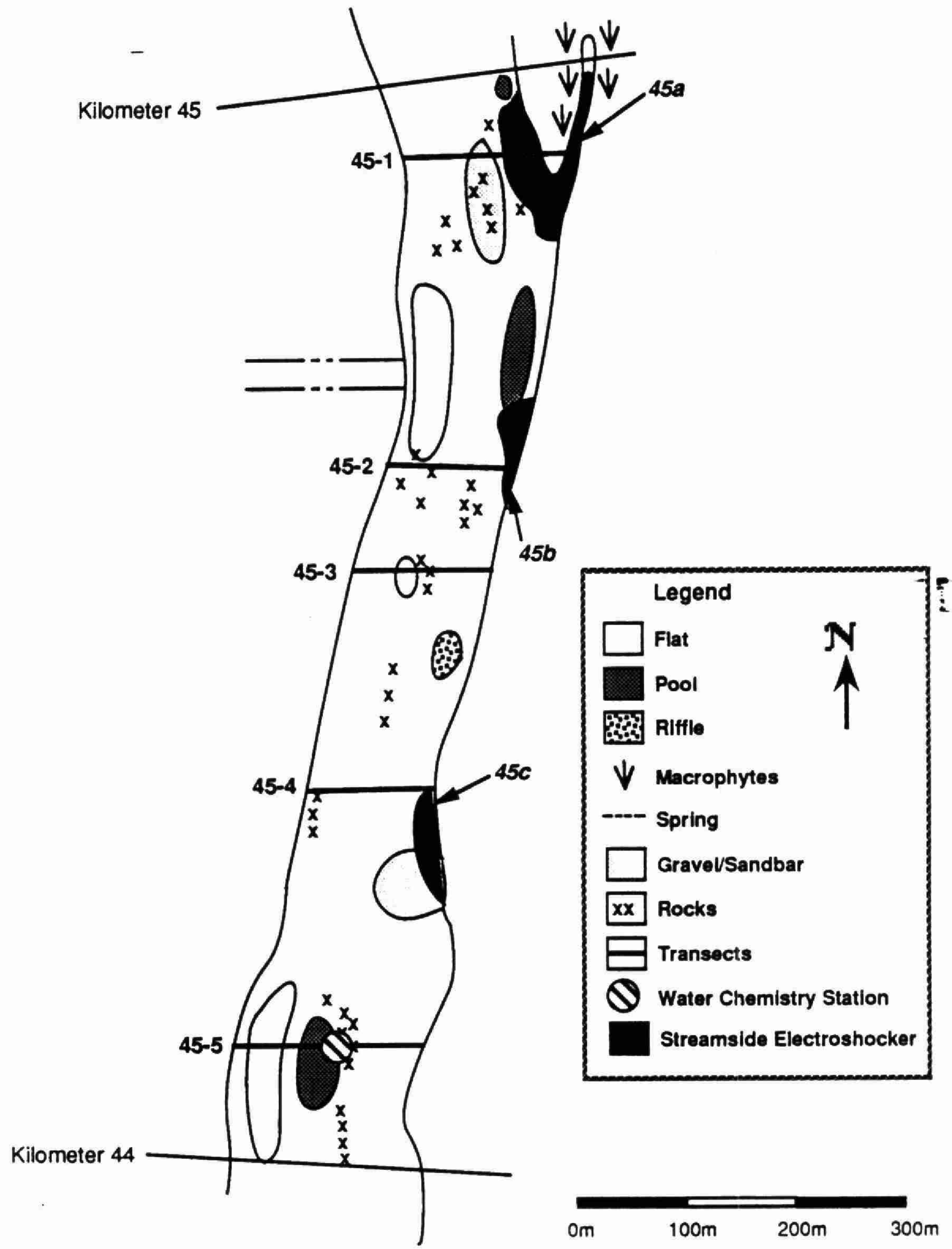
Appendix B-43. Instream Features and Collection Stations Kaministiquia River Kilometer 43, 1987.



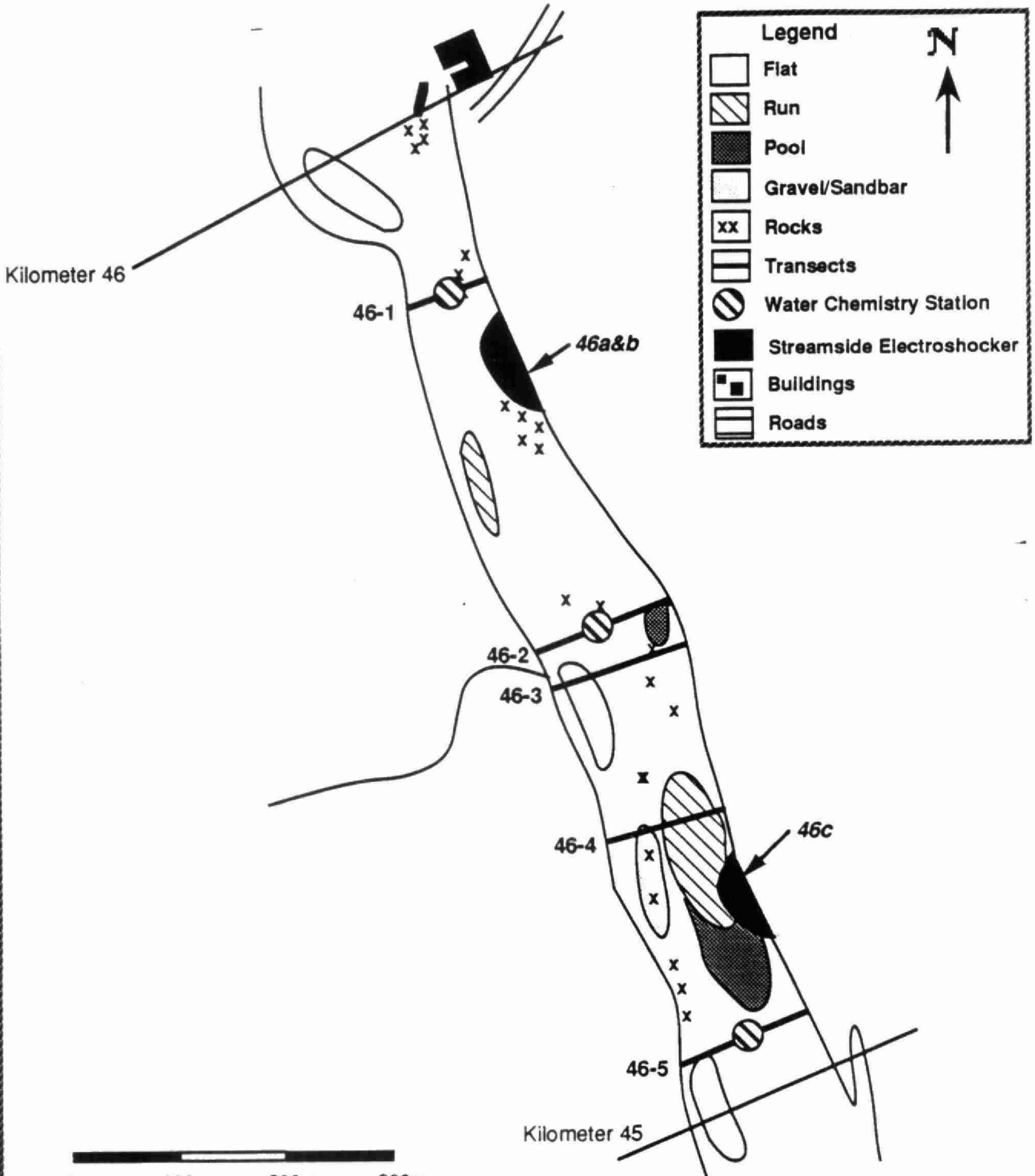
Appendix B-44. Instream Features and Collection Stations Kaministiquia River Kilometer 44, 1987.



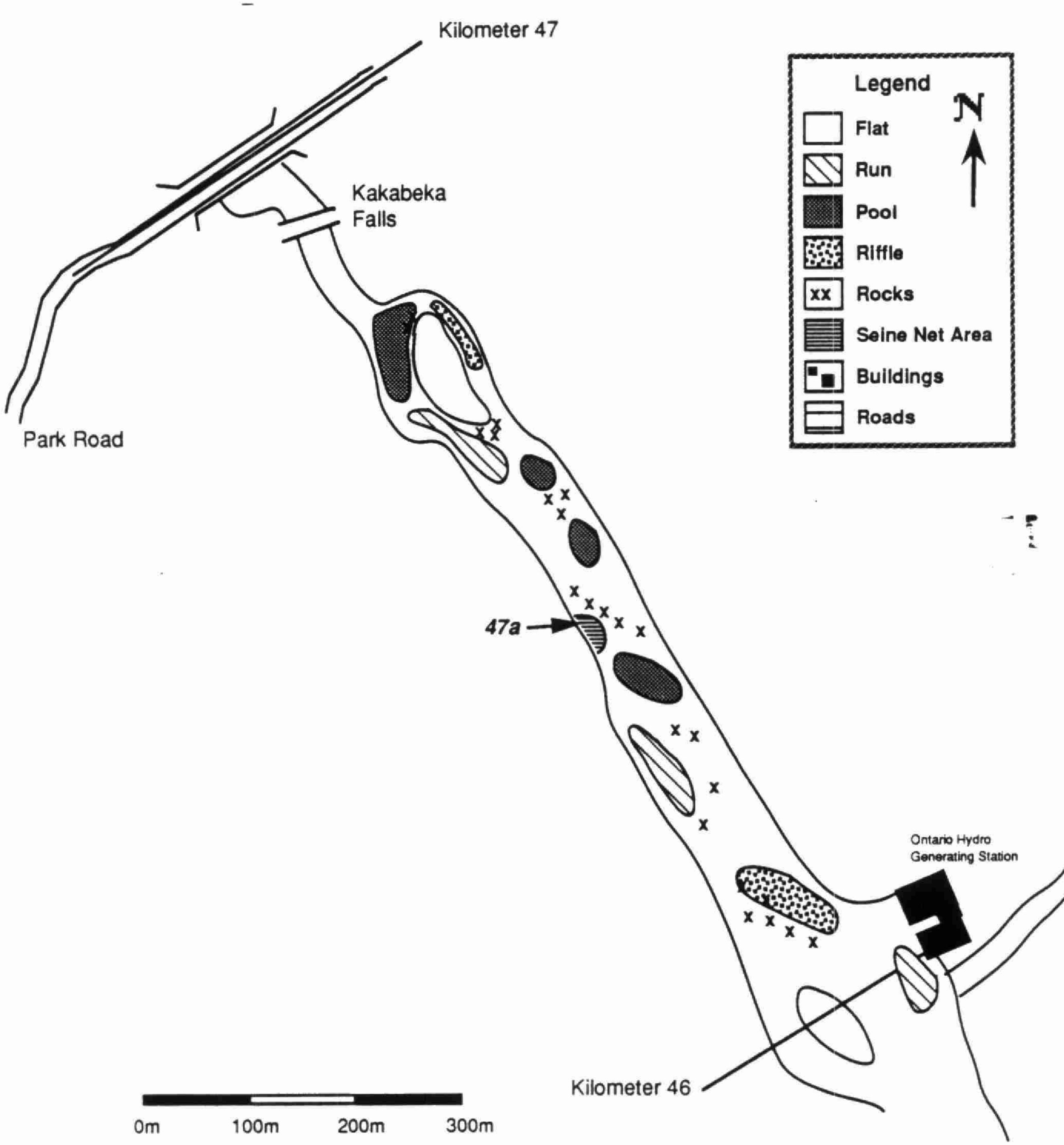
Appendix B-45. Instream Features and Collection Stations Kaministiquia River Kilometer 45, 1987.



Appendix B-46. Instream Features and Collection Stations Kaministiquia River Kilometer 46, 1987.



Appendix B-47. Instream Features and Collection Stations Kaministiquia River Kilometer 47, 1987.



Appendix C-1. Summary of 9.1 m bag seine catches from the Kaministiquia River, July 1 - September 9, 1987.

Collection station*	47a	44b	43c	42b	42c	42d	42e	42ee	42f	42g	42gg
Fish species											
Carp											
Creek Chub											
Blacknose Dace											
Finescale Dace											
Longnose Dace		6	1	5	16		10				
Fathead Minnow											
Blacknose Shiner											
Common Shiner											
Spottail Shiner											
Rock Bass											
Smallmouth Bass	1			1	1				1	7	
Black Crappie											
Northern Pike											
Walleye		14		2			1		10		
Yellow Perch							1				
Johnny Darter				50	12		193			2	
Logperch									1	7	
Longnose Sucker											
White Sucker		200	1	265	15		122		30		
Shorthead Redhorse											
Silver Redhorse		1									
Mottled Sculpin											
<u>Cottus</u> sp.				3	1		2				
Brook Stickleback							1				
Four-spine Stickleback											
Nine-spine stickleback											
Alewife											
Central Mudminnow											
Rainbow Smelt											
Trout-perch	1	2		3			6		3	28	

*Numbered stations represent kilometric distance from the mouth

Appendix C-2. Summary of 9.1 m bag seine catches from the Kaministiquia River, July 1 - September 9, 1987.

Collection station*	42i	41a	41b	41c	41d	41e	40b	39b	39c	39e	39g	38a
Fish species												
Carp												
Creek Chub												
Blacknose Dace									1			1
Finescale Dace												
Longnose Dace		1			1			11	6	6	2	
Fathead Minnow												
Blacknose Shiner												
Common Shiner										11	6	
Spottail Shiner										1	1	
Rock Bass		7					2	61	61	73	3	36
Smallmouth Bass		7				2		39	12	10	25	3
Black Crappie												
Northern Pike						2	1	2		4		2
Walleye		1		1			3		4			
Yellow Perch						2	2	12	8	1		18
Johnny Darter		14	10	5	6		16	32	171	16	3	4
Logperch		1					1			116	32	12
Longnose Sucker												
White Sucker	1	13	11	2	3	14	20	92	292	28	11	9
Shorthead Redhorse												
Silver Redhorse												
Mottled Sculpin			1									
<u>Cottus</u> sp.			2				4	3	4			4
Brook Stickleback									2			
Four-spine Stickleback												
Nine-spine stickleback												
Alewife												
Central Mudminnow									2			
Rainbow Smelt												
Trout-perch		6		2		3	8	2	14		2	

*Numbered stations represent kilometric distance from the mouth

Appendix C-3. Summary of 9.1 m bag seine catches from the Kaministiquia River, July 1 - September 9, 1987.

Collection station*	38b	38c	38d	38e	38f	37b	35a	35c	33b	29a	29b	29c
Fish species												
Carp												
Creek Chub												
Blacknose Dace	1		5		2							
Finescale Dace							1	1				
Longnose Dace					1		1					2
Fathead Minnow												
Blacknose Shiner			1									
Common Shiner	5											
Spottail Shiner												
Rock Bass	23	20	115	30	2			5				93
Smallmouth Bass	10	1	9	1	1			2				16
Black Crappie												
Northern Pike	2		2	1								
Walleye	2	1				1	1					
Yellow Perch	5	19	20									10
Johnny Darter	22		15	4	2	1	3	4				
Logperch		4	34							2		13
Longnose Sucker												
White Sucker	22	1	86	12	4	2	6	57				14
Shorthead Redhorse					1							
Silver Redhorse												
Mottled Sculpin					1							
Cottus sp.	3	1	1	5								
Brook Stickleback								2				2
Four-spine Stickleback												
Nine-spine stickleback												
Alewife												
Central Mudminnow												2
Rainbow Smelt												
Trout-perch	7	10	9									

*Numbered stations represent kilometric distance from the mouth

Appendix C-4. Summary of 9.1 m bag seine catches from the Kaministiquia River, July 1 - September 9, 1987.

Collection_station*	28c	27c	26a	26b	25a	25b	25d	25e	25f	24c	23a	23b
Fish species												
Carp												
Creek Chub												
Blacknose Dace												
Finescale Dace												
Longnose Dace												
Fathead Minnow				1								
Blacknose Shiner				1	1							
Common Shiner												
Spottail Shiner												
Rock Bass		2		4		3						
Smallmouth Bass		1	12		10	3	2	1	5	6	1	5
Black Crappie												
Northern Pike			1	1								
Walleye		2					1					
Yellow Perch		5				5	3		5			
Johnny Darter		1							1	1	1	
Logperch						1	4				1	3
Longnose Sucker												
White Sucker		3				9	5	3	1			6
Shorthead Redhorse												
Silver Redhorse												
Mottled Sculpin												
Cottus sp.												
Brook Stickleback		1					2					
Four-spine Stickleback												
Nine-spine stickleback												
Alewife												
Central Mudminnow						1						
Rainbow Smelt												
Trout-perch				1		8	14					

*Numbered stations represent kilometric distance from the mouth

Appendix C-5. Summary of 9.1 m bag seine catches from the Kaministiquia River, July 1 - September 9, 1987.

Collection station*	22a	22c	22d	22e	21a	21b	20a	20b	20c	20d	L-F	L-G
Fish species												
Carp												
Creek Chub			3	24								
Blacknose Dace												
Finescale Dace												
Longnose Dace				1								
Fathead Minnow												
Blacknose Shiner			1									
Common Shiner				58								
Spottail Shiner												
Rock Bass		3		2	2			4	6	111	39	64
Smallmouth Bass	7	12	1	27	6	1	1	4	7			
Black Crappie											1	
Northern Pike		1		2	1			1		2		
Walleye												
Yellow Perch	5	8		8	1		1	1	11	16	9	
Johnny Darter			1	10	1	2	1	2	12	9	6	
Logperch			1	2		1	3	3	13			
Longnose Sucker												
White Sucker	54	7	3	190	1				7	1	5	
Shorthead Redhorse												
Silver Redhorse				1			1			2		
Mottled Sculpin		1		1			1					
Cottus sp.												
Brook Stickleback				5						1		
Four-spine Stickleback												
Nine-spine stickleback												
Alewife												
Central Mudminnow				9					1		1	
Rainbow Smelt												
Trout-perch		1	2	32	8	1	9	1	1			

*Numbered stations represent kilometric distance from the mouth

Appendix C-6. Summary of 9.1 m bag seine catches from the Kaministiquia River, July 1 - September 9, 1987.

Collection station*	L-H	L-I	19f	19h	18e	18f	18g	17c	17d	16b	16c	15d
Fish species												
Carp												
Creek Chub												
Blacknose Dace												
Finescale Dace												
Longnose Dace												
Fathead Minnow			3									
Blacknose Shiner												
Common Shiner												
Spottail Shiner			61		82	1		28	26	1	7	1
Rock Bass	83	114	3		19	47		88	26	58	32	1
Smallmouth Bass			17	6	5		3	5	3			2
Black Crappie												
Northern Pike			2					2		1		
Walleye												
Yellow Perch	7	2	13		16	8		23		7	10	1
Johnny Darter			2	3	44	7		72	1	12	6	26
Logperch			5	3					2			
Longnose Sucker												
White Sucker			2				1	3		5	1	1
Shorthead Redhorse												
Silver Redhorse												
Mottled Sculpin												
Cottus sp.												
Brook Stickleback										1		
Four-spine Stickleback												
Nine-spine stickleback												
Alewife												
Central Mudminnow								2				
Rainbow Smelt												
Trout-perch												

*Numbered stations represent kilometric distance from the mouth

Appendix C-7. Summary of 9.1 m bag seine catches from the Kaministiquia River, July 1 - September 9, 1987.

Collection-station*	15e	14c	14d	13c	13d	13e	12e	11f	11g	10h	10i
Fish species											
Carp											
Creek Chub											
Blacknose Dace											
Finescale Dace									2		
Longnose Dace											
Fathead Minnow									3		
Blacknose Shiner											
Common Shiner											
Spottail Shiner						25	6	1	49		
Rock Bass	1	2	21	16	14	17	18	4	21	55	
Smallmouth Bass		6	11			7	1	11	1	9	17
Black Crappie											
Northern Pike	1						1	1	1	1	
Walleye											
Yellow Perch		5	25	1		4	2	2	19	5	3
Johnny Darter			16	1	16	3	7	4	45		
Logperch		3	3			1					2
Longnose Sucker											
White Sucker		2							8	8	1
Shorthead Redhorse											
Silver Redhorse											
Mottled Sculpin											
Cottus sp.											
Brook Stickleback										1	
Four-spine Stickleback											
Nine-spine stickleback											
Alewife											
Central Mudminnow		1									
Rainbow Smelt											
Trout-perch											

*Numbered stations represent kilometric distance from the mouth

Appendix C-8. **Summary of 9.1 m bag seine catches from the Kaministiquia River, July 1 - September 9, 1987.**

Collection station*	8c	8d	8e	7c	6c	5b	4c	3c	2c	1d
Fish species										
Carp	16		2	7	6	12	14	121	77	7
Creek Chub										
Blacknose Dace										
Finescale Dace										
Longnose Dace										
Fathead Minnow	2		2		7	1		6	65	
Blacknose Shiner										
Common Shiner										
Spottail Shiner					5			2	1690	5
Rock Bass	9	10	4		2	2				
Smallmouth Bass										
Black Crappie										
Northern Pike										
Walleye										
Yellow Perch	2			5						
Johnny Darter										
Logperch										
Longnose Sucker		7	20	56	31	11		14	26	
White Sucker	9	10	6	11	11	1	1	15	11	1
Shorthead Redhorse										
Silver Redhorse										
Mottled Sculpin										2
<u>Cottus</u> sp.										
Brook Stickleback		1	2	2	1		2	4	4	3
Four-spine Stickleback									2	5
Nine-spine stickleback									17	20
Alewife									36	
Central Mudminnow			1							
Rainbow Smelt										1
Trout-perch										

*Numbered stations represent kilometric distance from the mouth

Appendix D-1. Summary of streamside electro-shocker catches from the Kaministiquia River, June 29 to July 29, 1987.

Collection station[1]	46 a	46 b	46 c	45 a	45 b	45 c	44 a	44 c	43 a	43 d	43 e	37 a	37 c	* 37 d	37 e	37 f	36 a
Species caught																	
Rock Bass											1					1	1
Smallmouth Bass		1								7		5	6	1			5
Northern Pike				2		3				1							1
Walleye																	
Yellow Perch																	
Johnny Darter			2		X		1			2	5		1				
Logperch							1					1	1			2	
Burbot			2														
Rainbow Trout														2			
Brown Trout																	
Creek Chub														8			
Longnose Dace			3	5	8	6	3	3			3	3	1	91		1	3
Blacknose Dace																	
Finescale Dace														13			
Redbelly Dace														4			
Fathead Minnow														1			
Common Shiner			1											1			
Blacknose Shiner																	
Mottled Sculpin			2	4	1					2				15		2	
Slimy Sculpin		3	19	7	10											1	
Slimy X Mottled			1	2													
<u>Cottus</u> sp.	3					15	2	12	8		20	1					2
White Sucker			3	2	1	7			#	6	1	3	16	34		2	4
Longnose Sucker		1	1	5	1												
<u>Catostomus</u> sp.								6									
Redhorse Sucker																	
Brook Lamprey																	
Central Mudminnow						5	4		2	3	1						
Brook Stickleback																	
Trout-perch																	

[1]Collection station numbers represent kilometric distance from the river mouth
*-Oliver creek mouth
X-present
#-numerous fry caught

Appendix D-2. Summary of streamside electro-shocker catches from the Kaministiquia River, June 29 to July 29, 1987.

Collection station[1]	36 b	36 c	36 d	35 b	34 a	34 b	33 a	33 c	32 b	31 b	31 c	30 a	28 a	28 b	27 a	27 d	25 c
Species caught																	
Rock Bass	9	1	2	4	2	2	4	4	4	4	2	1	3	1	4	1	9
Smallmouth Bass	2	2	7	10	10	10	13	1	4	12	6	32	26	6	18	10	1
Northern Pike	1							1		1			1		1		
Walleye										1						1	
Yellow Perch						2	3					9		1	4	4	5
Johnny Darter		2		3	1	5	4	5	10	2		7		1	8	3	2
Logperch		3	3	4		1	4			2	1	18	8	14	16	35	3
Burbot			1														
Rainbow trout																	
Brown trout														1			
Creek Chub				1													
Longnose Dace	4	4	4		2	6	1			2	5		5	11		9	2
Blacknose Dace	6																
Finescale Dace																	
Redbelly Dace																	
Fathead Minnow																	
Common Shiner																	
Blacknose Shiner						2				1	2						
Mottled Sculpin	10	3	2	3	7	8	10	6	10	2	2	12	22	1	16	1	2
Slimy Sculpin		10	3	1	6		2			1	2	2	5	6		1	3
Slimy X Mottled									1				1			6	
Cottus sp.			1											3			
White Sucker	4	2	14	11	4	59	26	1	5	5	3	13	9	7	5	11	7
Longnose Sucker															1		
Catostomus sp.																	
Redhorse Sucker																	
Brook Lamprey	1	1	1			1		2					7				
Central Mudminnow					3	1	1	2	3	2	4	25	11		29	2	5
Brook Stickleback				3	2	1		1		2	2	4	1		1		
Trout-perch						1								6		2	1

[1] Collection station numbers represent kilometric distance from the river mouth

Appendix D-3. **Summary of streamside electro-shocker catches from the Kaministiquia River, June 29 to July 29, 1987.**

Collection-station[1]	24 d	23 c	22 b @
Species caught			
Rock Bass	5		1
Smallmouth Bass	5	4	9
Northern Pike	1	2	
Walleye			
Yellow Perch	21	4	6
Johnny Darter	1	5	8
Logperch			3
Burbot			
Rainbow trout			
Brown trout			
Creek Chub			8
Longnose Dace			
Blacknose Dace			
Finescale Dace			
Redbelly Dace			
Fathead Minnow			
Common Shiner			1
Blacknose Shiner	76		
Mottled Sculpin		1	3
Slimy Sculpin			
Slimy X Mottled			
Cottus sp.			
White Sucker	1	18	9
Longnose Sucker			
Catostomus sp.			
Redhorse Sucker			
Brook Lamprey	1		
Central Mudminnow	20	4	16
Brook Stickleback			1
Trout-perch		3	4

[1]Collection station numbers represent kilometric distance from the river mouth
@-Slate River mouth

Appendix E. Summary of electro-shocking boat catches by station from the Kaministiquia River, July 29-August 19, 1987.

Collection station*	15 c	14 b	13 b	12 c	11 a	10 a	10 b	9 b	8 b	7 b	6 b	4 a	3 a	2 a	1 a
Species caught															
Rock Bass	6	8	2	5	2	7	3								
Smallmouth Bass		4	4		3	1	6		2	1	1				
Northern Pike		2		4	1	1	1		1						
Walleye	5			3	1	2	8	1		2	1				
Yellow Perch	2	5		5	1	31	2	1		1					
Johnny Darter				1											
Logperch				1	3	4	1								
Carp								2		2					
Spottail Shiner		1		2	7	6									
Longnose Sucker										1					
White Sucker	1	2	4	1		6	1	2	1	1	2	5		6	
Silver Redhorse				2			14	9	4	15	1				
Shorthead Redhorse						2									
Trout-perch	151	23	30	226	53	39	14								
Central Mudminnow						2									

*Collection station numbers represent distance in km from mouth of the river.

Appendix F-1 . Summary of index gill net catches by station from the Kaministiquia River July 2-September 7, 1987.

Collection station*	43 b	32 a	30 c	24 a	L b	L c	19 b	18 a	17 b	16 a	15 b	14 a	13 a	12 b	11 b	10 c
Species caught																
Carp																
Longnose Sucker		2														
White Sucker		3	2		2	4	2	4	8	9	5	1	22	33	1	26
Silver Redhorse	1	1	1		5			4	4	1	1		1	1		
Shorthead Redhorse	3	6		5				2	1		2		3	2		
Unknown Redhorse sp				3												
Burbot							1									
Rock Bass		1		2		5	18	5	8	8	6	11	11	20	5	1
Northern Pike	3			1		1				1	1		2		1	
Smallmouth Bass		2		2				3		2						
Yellow Perch					2	7	5	6	3	3	4	4	1	5		1
Walleye		1	1	1				3	3	4	3	5	4	2		
Lake Sturgeon								2	2			2	1	1	1	6
Alewife						12										

*Collection station numbers represent distance in km from the mouth of the river
"L" represents the oxbow loop by km 19
"M" represents sets off the river's mouth

Appendix F-2 . Summary of index gill net catches by station from the Kaministiquia River July 2-September 7, 1987.

Collection statio*	10 e	9 a	8 a	7 a	6 a	5 a	4 b	3 b	2 b	1 c	M b	M c	M d
Species caught													
Carp					1								
Longnose Sucker		1	12	14	3	10		6	5	1	47	12	
White Sucker	1	29	15	4				1	6	13	66	67	15
Silver Redhorse	1												
Shorthead Redhorse				1									
Burbot												1	
Rock Bass												1	
Northern Pike												2	
Smallmouth Bass													
Yellow Perch	1								1	2			
Walleye			1								1	9	
Lake Sturgeon		1											
Alewife													

*Collection station numbers represent distance in km from the mouth of the river
"L" represents the oxbow loop by km 19
"M" represents sets off the river's mouth.

Appendix G. Gravel composition of potential salmonid spawning shoals Kaministiquia River, 1987

Station	Location on transect	Depth (m)	Flow (cm\sec)	Substrate size (% by volume) <19mm	12mm	1.5mm	≤1.5mm
44-1		0.24	17.1	48	11	38	3
44-5		0.40	42.0	60	11	23	6
43-5		0.38	65.5	44	9	38	9
36-3	right side	0.17	48.2	55	7	27	11
34-3	left centre	0.18	58.8	46	9	36	9
34-3	right centre	0.17	49.2	45	12	34	9
34-4	right side	0.28	37.5	31	16	46	7
34-4	left side	0.27	54.8	19	14	48	19
30-2	left side	0.22	30.8	66	6	19	9
29-5	left side	0.24	58.8	48	11	17	24
26-5	left side	0.26	52.7	63	8	21	8
25-2	mid-right	0.25	50.7	28	15	42	15
25-2	mid-left	0.46	78.7	23	14	46	17
25-2	left side	0.25	48.2	17	17	50	16
25-4	left side	0.36	45.6	41	11	32	16
23-2	left side	0.31	41.5	55	7	21	17
23-3	far left	0.22	70.8	39	13	30	18
23-5	left centre	0.60	45.1	33	17	33	17
22-2	left	0.35	51.7	54	8	25	13
22-3	right side	0.52	77.2	57	8	27	8
22-3	left side	0.53	83.8	56	9	23	12
21-1	left side	0.30	43.6	48	11	24	17
21-4	left side	0.37	66.0	43	13	29	15

Appendix H. Kaministiquia river water chemistry stations 1987

Station	Station Depth (m)	Conductivity (umho\cm) (25 C.)	Alkalinity (Mg\L) (CaCO3)	pH	Turbidity (FTU)	Colour (true)	Total Phosphorus (Mg\L)	Total Phosphates (Mg\L)	Total Nitrogen (Mg\L)	Total Nitrates (Mg\L)	Nitrite (Mg\L)	Secchi (m)	Site Description
46-1	0.58	85.00	32.85	7.65	3.10	59.0	.012	.002	.390	.106	.004	CTB	Below Kakabeka G.S.
46-2	0.41	86.00	32.94	7.73	2.60	60.0	.011	.002	.440	.104	.003	CTB	Below Kakabeka G.S.
46-5	0.50	86.00	32.92	7.81	2.50	60.0	.011	.002	.410	.101	.003	CTB	Below Kakabeka G.S.
45-5	1.30	87.00	33.55	8.02	3.20	60.0	.012	.001	.390	.086	.005	NA	2 km below falls
44-5	0.93	86.00	33.57	8.19	2.70	61.0	.012	.001	.380	.084	.004	CTB	3 km below falls
43-5	1.56	85.00	32.87	8.13	2.70	56.0	.016		.410	.085	.005	CTB	Harstone Bridge
42-4	1.43	85.00	32.97	8.28	2.30	56.0	.013		.440	.084	.003	CTB	+ Whitefish R.
42-5	1.44	83.00	33.03	8.31	2.40	56.0	.011		.380	.082	.004	CTB	- Whitefish R.
41-5	1.35	97.00	39.06	8.01	3.20	54.0	.011		.380	.087	.003	CTB	+ Stanley bridge
40-5	1.42	83.00	34.00	7.90	2.30	56.0	.012		.370	.130	.003	L-0.90	- Stanley bridge
39-5	1.26	83.00	34.00	7.90	2.00	57.0	.010		.360	.127	.003	R-1.10	- Stanley bridge
38-5	1.71	86.00	36.00	7.70	2.20	57.0	.015		.380	.132	.003	CTB	- Stanley bridge
37-2	2.00	91.00	37.00	7.70	2.50	56.0	.014	.001	.390	.135	.003	1.70	+ Corbett Creek
37-3	1.06	112.00	46.00	7.90	12.00	60.0	.041	.012	.440	.118	.005	0.50	- Corbett Creek
36-5	0.66	127.00	52.00	8.00	17.00	85.0	.033	.013	.600	.130	.008	CTB	- Corbett Ck.
35-5	0.71	112.00	45.00	7.70	13.00	82.0	.030		.620	.140	.007	0.53	+ Rosslyn rapids
34-5	0.62	129.00	53.00	7.80	7.60	78.0	.025	.006	.560	.120	.004	CTB	- Rosslyn rapids
33-5	1.41	128.00	53.00	7.80	7.00	83.0	.022	.006	.530	.110	.005	0.75	+ Rosslyn brick yard
32-5	1.02	114.00	47.00	7.80	5.50	86.0	.022	.006	.560	.130	.005	CTB	+ Rosslyn brick yard
31-5	0.65	114.00	47.00	7.80	5.50	91.0	.020	.005	.590	.110	.005	CTB	Brick yard
30-5	1.42	118.00	46.00	7.80	3.80	87.0	.020	.005	.580	.082	.004	1.13	- brick yard
29-5	0.80	122.00	47.00	7.80	6.20	85.0	.032	.012	.590	.084	.004	CTB	+ Cooper's pit
28-5	0.90	131.00	51.00	7.80	6.20	85.0	.032	.012	.580	.076	.005	0.63	+ Rosslyn bridge
27-5	1.01	129.00	51.00	7.80	10.00	91.0	.031	.013	.620	.077	.005	0.65	- Rosslyn bridge
26-5	0.74	110.00	47.00	7.70	4.90	80.0	.022	.003	.550	.081	.004	CTB	upstream of islands
25-5	1.33	110.00	47.00	7.80	3.50	78.0	.021	.003	.540	.073	.004	CTB	25 km from mouth
24-5	0.61	118.00	45.00	7.80	3.50	75.0	.017	.004	.470	.076	.005	CTB	- backwater area
23-5	1.16	117.00	48.00	7.80	3.80	78.0	.015	.003	.480	.074	.005	CTB	+ Slate R.
22-3	0.75	245.00	83.00	8.30	14.00	108.0	.039	.018	.740	.024	.007	CTB	- Slate R.
22-5	0.92	104.00	44.00	7.80	2.50	74.0	.015	.005	.470	.070	.006	CTB	- Slate R.
21-5	1.17	108.00	46.00	7.80	2.40	75.0	.015	.005	.490	.070	.005	CTB	+ Oxbow loop
20-5	2.89	120.00	45.00	7.80	3.30	72.0	.022	.005	.510	.090	.004	1.41	+ Old Fort William
R-5	1.46	148.00	56.00	7.90	8.50	78.0	.032	.012	.520	.015	.005	0.72	by Bowlker's farm
L-5	3.60	130.00	50.00	7.80	9.80	77.0	.024	.010	.540	.031	.005	0.66	top of oxbow loop
19-5	4.32	101.00	41.00	7.80	3.80	65.0	.018	.003	.460	.091	.005	1.20	- Old Fort William
18-5	3.00	84.00	38.00	7.70	3.00	65.0	.018	.003	.460	.110	.005	1.07	18 km from mouth
17-5	3.00	96.00	39.00	7.70	3.00	65.0	.013	.003	.540	.110	.005	1.16	17 km from mouth
16-5	4.70		36.00	7.70	3.70	61.0	.020	.003	.440	.110	.004	1.10	16 km from mouth
15-5	4.50	100.00	37.00	7.90	3.70	63.0	.020	.003	.430	.110	.004	1.30	- Riverdale Rd.
14-3	6.00	100.00	37.00	7.90	3.60	62.0	.020	.004	.480	.110	.004	1.34	by Victor St.
13-5	6.00	100.00	36.00	7.70	3.80	62.0	.010	.003	.490	.110	.004	1.17	below Victor st.
12-4	4.00	130.00	35.00	7.70	4.40	62.0	.020	.003	.510	.110	.004	1.13	+ Hwy. 61 bridge
11-5	7.00	130.00	35.00	7.70	4.50	61.0	.008	.004	.540	.110	.004	1.05	- Hwy. 61 bridge
10-5	9.00	130.00	41.00	7.30	16.00	150.0	.086	.018	.640	.020	.008	0.51	CPFP mill
9-4	10.50	210.00	39.00	6.90	9.20	111.0	.053	.006	.650	.018	.005	0.68	turning basin
8-3	8.50	222.00	39.00	6.90	9.20	109.0	.053	.006	.650	.018	.006	0.55	below turning basin
7-4	8.90	219.00	39.00	6.90	8.00	104.0	.048	.004	.590	.019	.005	0.66	below swingbridge
6-4	8.50	216.00	40.00	6.90	7.70	99.0	.050	.007	.610	.015	.006	0.62	6 km from mouth
5-5	9.00	195.00	41.00	6.90	7.10	82.0	.046	.009	.660	.044	.007	0.74	Thunder Bay Chemicals
4-3	8.50	189.00	43.00	7.00	5.20	70.0	.048	.009	.660	.091	.007	0.84	below Jacknife bridge
3-3	10.00	194.00	45.00	7.10	6.20	62.0	1.900	.075	1.200	.110	.006	0.76	3 km from mouth
2-4	9.50	187.00	46.00	7.20	5.10	43.0	.130	.041	1.100	.150	.006	0.85	2 km from mouth

Appendix I-1. Numbers of young-of-the-year game fish collected using the streamside electroshocker, shocking boat and the 9.1 m bag seine, Kaministiquia River 1987.

Collection station	47a	45a	45c	44b	43a	43d	42b	42c	42d	42f	42g	41a
Smallmouth Bass	1					7		1			3	7
Walleye				14			2		1	10		1
Northern Pike		2	3		1	1						

Collection station	41c	41e	40b	39b	39c	39e	39g	38a	38b	38c	38d	38e
Smallmouth Bass		2		39	12	10	25	3	10		9	1
Walleye	1		3		4				2	1		
Northern Pike		2				3		1	1			1

Collection station	38f	37a	37b	37c	36a	36c	35a	35b	35c	34a	34b	33a
Smallmouth Bass	1	5		6	5	1		2	1	10	10	13
Walleye			1				1					
Northern Pike					1							

Collection station	33c	32b	31b	31c	30a	29c	28a	28b	27a	27c	27d	26a
Smallmouth Bass	1	3	12	6	32	16	26	6	18	1	10	1
Walleye			1							2	1	
Northern Pike			1						1			

Appendix I-2. Numbers of young-of-the-year game fish collected using the streamside electroshocker, shocking boat and the 9.1 m bag seine, Kaministiquia River 1987.

Collection station	26b	25a	25c	25d	25e	25f	24c	24d	23a	23b	23c	22a
Smallmouth Bass		10	1	2	1	5	6	5	1	5	4	7
Walleye				1								
Northern Pike	1							1			2	

Collection station	22b	22c	22e	21a	21b	20a	20b	20c	20d	19f	19h	18e
Smallmouth Bass	9	12	27	6	1	1	4	7		17	6	5
Walleye												
Northern Pike				1					2			

Collection station	18g	17c	17d	15c	15d	14b	14c	14d	13b	13e	12c	12e
Smallmouth Bass	3	5	3		2	4	6	11	3	7		1
Walleye				5							3	
Northern Pike												

Collection station	11a	11f	11g	10a	10b	10h	10i	8b	6b
Smallmouth Bass	3	11	1	1		9	17	2	1
Walleye	1			1	2				
Northern Pike									

APPENDIX J. Variables used for each species in HSI model

	chinook salmon	rainbow trout	walleye	longnose dace	smallmouth bass	white sucker	common shiner
pH	●	●	●		●	●	●
Temperature [1]	●	●		●			●
Disolved Oxygen	●	●	●		●	●	
% pools	●	●			●	●	●
Pool class rating	●	●					●
Max. temp (late summer)	●				●		
Avg. water velocity	●					●	
% fines	●	●					
Rate of base flow/daily flow	●	●					
Peak flow	●						
Predominant substrate	●	●	●		●	●	●
Avg. % fines	●						
Nitrate - nitrogen	●						
% stream cover	●		●	●	●	●	
% riffles	●			●			
Max. depth of riffle	●			●		●	
Avg. current		●		●			●
% stream area [2]				●			
Avg. turbidity					●	●	●
Avg. temp at spawning							●
Avg. temp for life stages			●			●	
Avg. thalweg depth		●					
Avg. substrate size		●					
% substrate class		●					
% ruparian vegetation		●					
% ground cover		●					
% shade		●					
Avg. transparency			●				
Forage fish [3]			●				
Avg. pool depth					●		
Avg. TDS [4]					●		
Water level fluctuation					●		
Stream gradient					●		

1 minimum, average and maximum temp.
2 area with substrate of at least 5-20 cm diameter
3 relative abundance
4 total dissolved solids in mg/l

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